

# CEREAL CHEMISTRY

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## REPORT OF COMMITTEE ON STANDARDIZATION OF EXPERIMENTAL BAKING TEST<sup>1</sup>

With Minor Changes and Corrections as Made by the Baking Committee of the American Association of Cereal Chemists  
and Adopted by the Association

C. G. HARREL, Chairman

(Read at the Convention, May, 1929)

This report is the outcome of a recent (March 12-14, 1928) meeting of the Committee on Standardization of the Experimental Baking Test, of the American Association of Cereal Chemists, and briefly indicates the present status of the project. A definite, fixed procedure, based upon principles previously established (1927), has been approved by the committee as a tentative method and is herewith proposed as a standard laboratory baking procedure. This report is confined especially to a statement of the formula and method to be employed in the basic procedure. Certain supplementary procedures are also indicated, including a description of equipment specified for the performance of the basic standard test.

### Basic Procedure

#### Ingredients:

Flour, 100.0 m. gm. on 15% moisture basis (85 gm. dry matter).

Yeast, 3.0 gm. (3%).

Salt, 1.0 gm. (1%) 99.5% pure.

Sugar (sucrose), 2.5 gm. (2½%).

Water (distilled), to 58% absorption with flour on a 15% moisture basis. (To determine the exact quantity of water to be added, subtract from 158 the weight of flour used as previously computed.)

### Procedure

**Mixing.**—Dissolve salt and sugar in a portion of the water. The weighed portion of yeast may be disintegrated in the salt-sugar solution or in another portion of the water, altho the yeast should

<sup>1</sup> This report is a copy of the report published in Cereal Chem. vol. 5, pp. 158-161 by M. J. Blish. A few minor changes and corrections have been made. These should be carefully noted by laboratories using the Standard Experimental Baking Test.

not be allowed to stand in contact with the salt-sugar solution before mixing the dough. (Stock solutions may be used, but care must be taken to correct for water added.) Add the flour and mix with flexible spatula that will conform readily to shape of bowl, making 125 "cuts" with spatula. Temperatures of ingredients must be so regulated that the dough comes from the mixing operation at 30°C. Remove dough from bowl, and fold 20 times in the hands.

**Fermentation.**—Place in fermentation bowl and allow to ferment at 30°C. (plus or minus 0.5°C.), and not less than 75% relative humidity. At the end of 105 minutes remove dough from bowl, fold 15 times in the hands (first punch), return dough to bowl, and let fermentation proceed as before. At 50 minutes after the first punch, again remove dough, fold 10 times (second punch), and replace in fermentation bowl. Mold and pan dough at expiration of 25 minutes after second punch.

**Molding and panning.**—Place dough on table or molding board and pound vigorously with heel of the hand until the dough is flat and circular, as in 1<sup>2</sup>. Holding one side of the dough, cut the circular dough mass loose from the table with the spatula, and turn on reverse side. Fold over two opposite sides so that they overlap to a considerable degree, as in 2. Turn dough over, and again pound flat with heel of hand. Holding one end, cut dough loose from table with spatula, and turn on reverse side, with seam of dough running away from operator. Starting at the more remote end, roll toward operator, folding as tight as possible, as in 3. Seal the seam tightly, and with seam on the bottom, seal ends by pinching them vertically. Roll lightly under palm of hand, adjusting dough to length of pan, and place in pan with seam down. The length of dough should not exceed that of the pan prior to the final light rolling. No dusting flour is used in the molding process.

**Proof.**—Proof 55 minutes under same conditions as for fermentation.

**Baking.**—Bake 25 minutes at a temperature of 230°C. plus or minus 5.0°C. When the oven is loaded there will be a drop in temperature, the fall depending on the load. The temperature should rise to 230°C. within 5 minutes and be maintained within plus or minus 5°C. during the remainder of the baking period.

The temperature is to be taken level with the top of the pan and 5 cm. distant therefrom on the side next to the axis of rotation.

Weigh loaf and measure volume 30 minutes after removal from oven.

<sup>2</sup> See Cereal Chem. vol. 5, p. 160 (March, 1928).

### Additional and Supplementary

#### A. Absorption

Basic procedure in which absorption only is varied.

#### B. Fermentation

Basic procedure varying fermentation time only.

#### C. Addition of special oxidizing reagent, potassium bromate.

Basic procedure with addition of potassium bromate in successive increments of 1 mg.

It is suggested that a volumetric solution of the potassium bromate be made, so that 1 cc. equals 1 mg. of potassium bromate. The potassium bromate should be of highest purity as determined by titration.

#### D. Mechanical Modification

Basic procedure varying mixing conditions only.

### Special Equipment Needed

**Mixing bowl.**—Ordinary graniteware "oatmeal bowl," top diameter 16.5 cm., bottom diameter 5.7 cm., and depth 7.3 cm.

**Fermentation bowl.**—Same as mixing bowl, but smaller. Top diameter 12.7 cm., bottom diameter 5 cm., and depth 5.7 cm.

**Spatula.**—Flexible steel blade, approximately 12.7 cm. long by 1.9 cm. wide.

**Baking pan.**—Dimensions: Bottom inside, 53x93 mm.; height (sides), 85 mm.; height (ends), 68 mm.; top inside (at height of 68 mm.) 60x105 mm. Pans to be made from 4X (0.55 mm.) spotless metal, which requires no greasing.

**Other equipment.**—Fermentation cabinet and oven, both with precise temperature control.

**Volume measuring apparatus.**—This should be calibrated gravimetrically as set forth in Cereal Chemistry, vol. 5, pp. 220-222, 1928.

It is suggested that four points of known volumes, namely, 300, 400, 500, and 600 cc., be determined. By plotting these four points against their corresponding values as measured by the apparatus, the calibration curve for the apparatus is obtained. This calibration likewise corrects for peculiarities of the operator, providing such are uniformly and consistently practiced.

#### Thermometers<sup>3</sup>

A. Fermentation cabinet and dough testing.—The American Association of Cereal Chemists official dough testing thermometer should be used. This thermometer is graduated from 15° to 40°C. For

<sup>3</sup> As soon as these thermometers are available, announcement will be made through Cereal Chemistry.

those demanding the Fahrenheit scale, this thermometer is available so graduated and made according to the official specifications.

B. Oven thermometers.—American Association of Cereal Chemists official oven thermometer should be used. This thermometer has a range from 100° to 260°C. As in the case of the dough thermometer, this thermometer is available graduated for the equivalent temperatures in degrees Fahrenheit.

#### Recording and Reporting Results

In reporting results the Standard A. A. C. C. Baking Test report by M. J. Blish, as published in this issue of Cereal Chemistry, should be used. Photographic reproductions of the standard external types will be found in Cereal Chemistry, vol. 5., pp. 292-294. The reproductions of the standard internal types appear in this issue of Cereal Chemistry, pages 255-258.

#### Acknowledgment

The committee herewith gratefully acknowledges the co-operation of the members of the association and manufacturers of apparatus and equipment. We sincerely thank you.

#### Statement of the Expenses and Activities of the Baking Committee

C. G. HARREL, Chairman

The baking committee of this year has actively engaged in the work pertaining to the advancement of the baking test. In order that members of the association can more thoroly understand the committee's endeavors, a statistical summary has been prepared. This summary is divided as follows:

1. Expenses incurred by committee members and apparatus manufacturers working for the development of the Standard Experimental Baking Test.

2. Activities of committee members.

The expenses are as follows:

#### Expenses

Personal, for attendance at committee meetings.....	\$ 603.50
Total amount expended in conducting baking experiments.....	819.00
Miscellaneous .....	584.50
Total defrayed by committee members.....	2,007.00
Expenses of manufacturers in developing new apparatus, namely, ovens, thermometers, mixing machines, etc.....	3,500.00
Total of all expenses .....	\$5,507.00.



This financial statement does not include an evaluation of the salaries of committee members while working on committee problems.

Concerning the expenses of the manufacturers, there will undoubtedly be a tendency to say that such is a part of their business routine. I wish to state emphatically that the manufacturers have gone much further than their regular business routine. They have expended money and assisted the committee in numerous ways, and certainly deserve the respect and gratitude of our association.

Following is a short summary of the committee members' activities.

Letters written concerning committee work.....	1,133
Telegrams sent .....	48
Papers or articles written .....	17
Experiments .....	657
Bakings made .....	1,851
Photographs taken .....	300
Lantern slides made .....	212
Baking pans, thermometers, etc. ....	24
New apparatus constructed .....	5
Approximate time spent on baking committee work, hours .....	3,535
or 16.1 working months	

From this summary and the reports of the members of the committee you can realize the immense amount of work your committee has undertaken during the last year.

The committee has been greatly handicapped because three members were unable actively to engage in the work, owing to their business relations. The committee is conscious of the many problems of the baking test that require additional investigation. The perfection of a Standard Experimental Baking Test is one of the greatest problems ever undertaken by our association.

### Reporting System For the Standard Experimental Baking Test

M. J. BLISH

University of Nebraska, Lincoln

The fundamental requirements of the standard baking test reporting system, as outlined in the last report of the baking test committee (1928), may be here briefly re-emphasized. In considering the proposed method for reporting loaf characteristics there must first be a general realization and recognition of the fact that "reporting" and "scoring" are two separate and distinct procedures, the former being exclusively an attempt to record facts, while the latter, to a greater or lesser degree, registers personal opinion and judgment as to excellence or inferiority. It should be possible at least partially to

standardize a system for recording facts, whereas any serious attempt to standardize personal preference is out of the question. This is no attempt to deny that scoring is a necessary and vital act, which must always be resorted to in the interpretation of baking results. It is merely an assertion of a belief that scoring is to be regarded as a separate and individual operation, subject to special requirements and purposes, and therefore outside the domain of standardization.

The Standard Experimental Baking Test report is obviously nothing more or less than a recorded statement of loaf characteristics. The report form (See p. 258.) presents no novel features other than the strict avoidance, so far as present circumstances permit, of all elements pertaining to *scoring*. It will be observed that the report form makes no provision for rating grain, texture, etc., on a numerical basis. Where numbers or letters are employed, they are used for reference to type only, with no implied superiority of one type over another. The use of terms such as "good," "excellent," "poor" is scrupulously avoided. The accompanying report form provides spaces for recording the individual loaf characteristics, respectively, and the methods suggested for recording them are indicated in a series of footnotes below the proposed form.

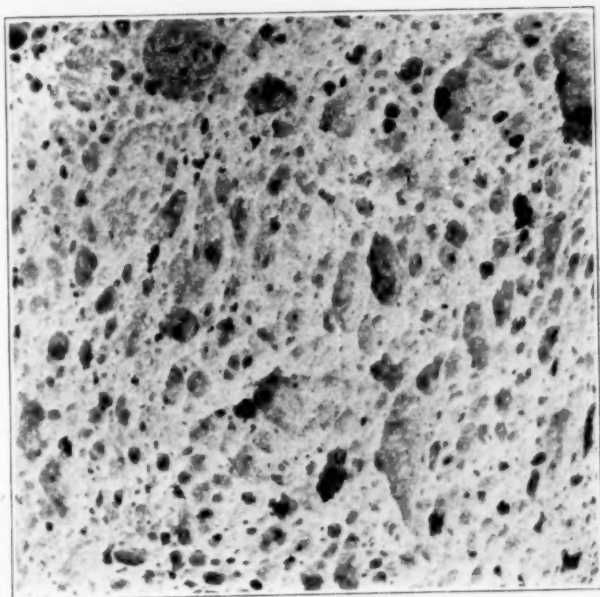
The type photographic models for external characteristics remain tentatively as they appear in the published report of last year (1928). For *internal* characteristics, however, a new and different series of type models (photographic) is herewith offered for use as prescribed in footnote 2, on the accompanying report form. Sets of reference photographs, for both external and internal test loaf characteristics, may be obtained, if desired, from M. J. Blish, Agricultural College, Lincoln, Nebraska, at nominal cost.

This tentative reporting system is offered in all due recognition of the probability of subsequent alterations and improvements. For instance, it is hoped and expected that a method for reporting crust color by letter or number, as ascertained by comparison with a standard color chart, will soon be developed.

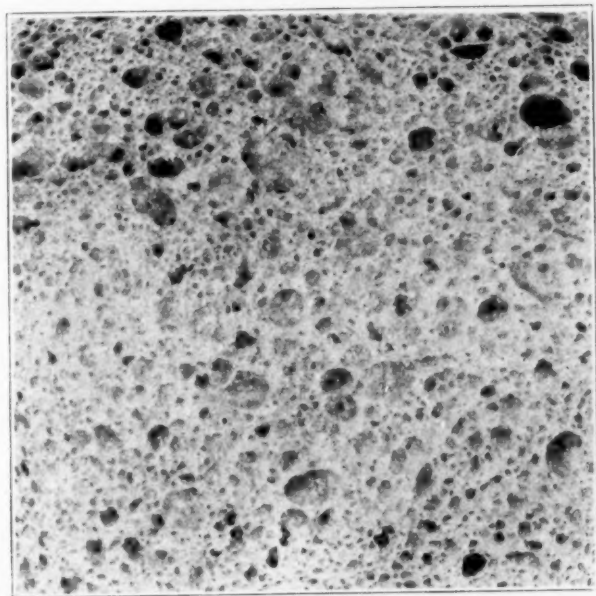
#### Literature Cited

- Blish, M. J.  
1928 Proposed reporting system for standard baking test. Cereal Chem.  
5:289-294.

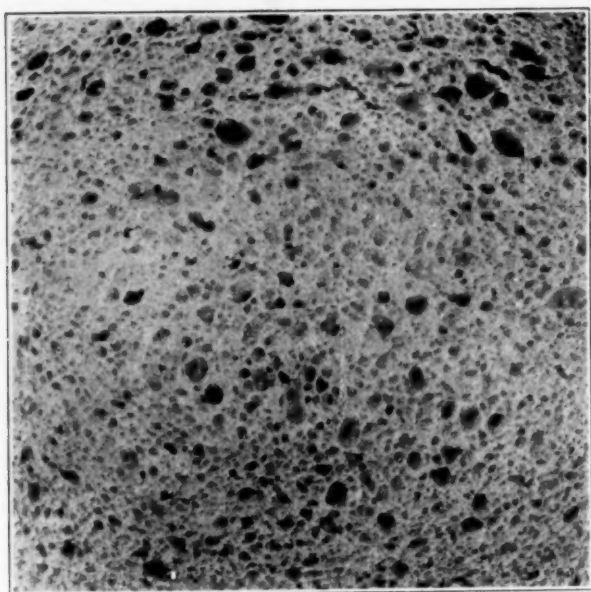
# REFERENCE MODELS FOR INTERNAL LOAF CHARACTERISTICS



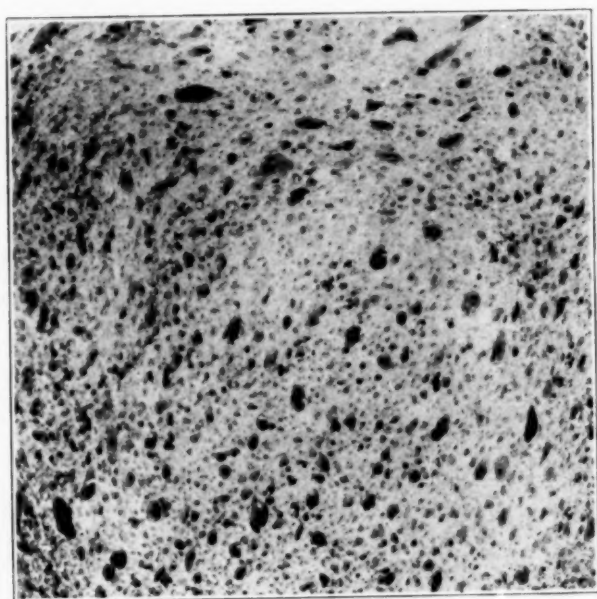
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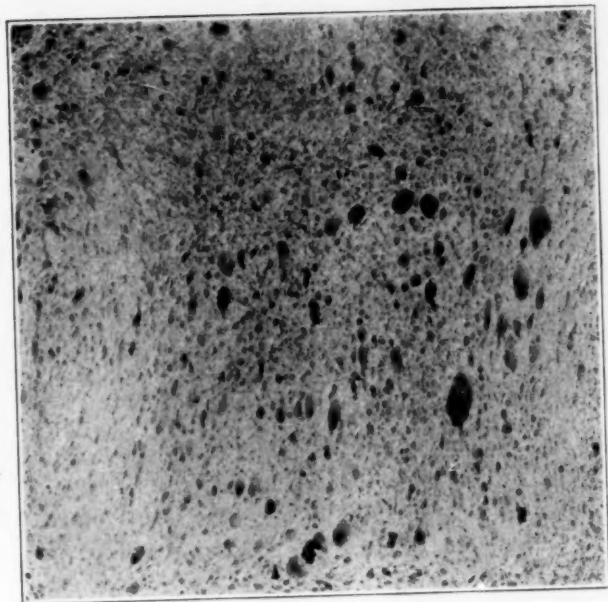
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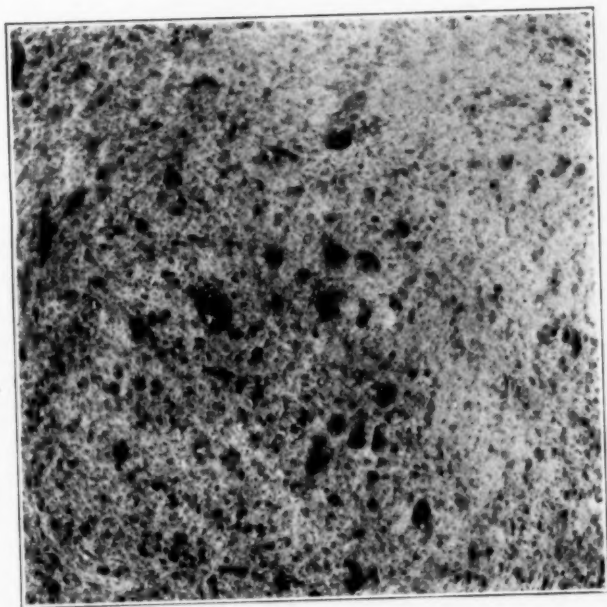
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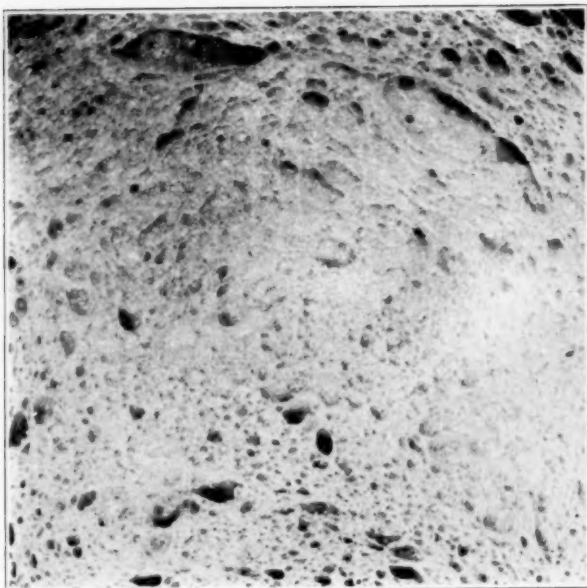
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5



6



7

# STANDARD A. A. C. C. BAKING TEST REPORT (PROPOSED)

Sample No.				
Basic Test				
Supplementary				
Moisture (%)				
Flour used (gm)				
Water used (cc)				
Loaf volume (cc)				
Loaf weight (gm)				
External 1				
Internal 2				
Firmness of crumb 3				
Texture 4				
Crust color 5				
Crust mottling 6				
Crumb color 7				
Remarks				

1 External. A single letter, as F, G, or H, denotes resemblance to one of the standard types or models. A combination of 2 letters, as FG, GF, GH, denotes combined characteristics of two types, the predominating type indicated by the first letter. The small letters, s, m, or l, may be added if desired, as Fs, Gm, to indicate that the break is small, medium, or large as compared with the type model.

2 Internal. Resemblance to type is reported by number. Nos. 1 to 5, inclusive, denote pronounced gradations in size of grain for round cell structure only. Elongated cell structure may be indicated by adding the letter E. Intermediate gradations are denoted by the use of plus or minus signs. Thus, 2+ means a grain finer than 2 but coarser than 3. Nos. 6 and 7 are special types, 6 denoting the fluffy thin-walled cells, while 7 represents an irregular, distorted structure. Nos. 6 and 7, respectively, may be combined with any one of the other numbers to indicate both size and structure. Thus "6-3" denotes the fairly large grain of 3, but with the thin cell walls of 6, while "7-2" denotes the large grain of 2 combined with the distorted appearance of 7.

3 Firmness of Crumb. S(trong), M(edium), or W(eak).

4 Texture. H(arsh), M(edium), or S(oft).

5 Crust color. By letter or number, or D(ark), M(edium), or P(ale).

6 Crust mottling. Use plus or minus signs, i.e., +, ++, +++, -.

7 Crumb color. Wh, Cr, Gr, Y, etc.



### Yeast Testing

R. J. CLARK, Schulze Baking Co., Kansas City, Mo.

It is believed that a method for testing yeast, to be of service to the greatest number of workers, should among other things meet the following requirements:

1. It should be short (require about 20 minutes to run).
2. It should be easy to perform.
3. It should be accurate. An error of  $\frac{1}{2}\%$  on duplicate runs should be a maximum.
4. The apparatus required should not be elaborate.
5. All uncontrollable factors used as a medium for yeast culture should be eliminated.

Two methods have thus far been presented as possibilities for testing yeast.

1. Introducing the yeast into a culture medium consisting entirely of a chemical nutrient solution and measuring the evolved gas.
2. Mixing the yeast into a standard dough, measuring the evolved gas during fermentation, and then baking the bread.

Work under the first procedure, namely, introducing the yeast to be tested into a culture medium consisting entirely of a chemical nutrient solution and measuring the evolved gas, has been carried out in several stages.

The first method was to ferment a given quantity of yeast in a specified sugar solution under rigidly set conditions and try to measure the evolved carbon dioxide under pressure. This method failed because if the flask containing the yeast sugar mixture should be jarred or moved, checking results were impossible.

The second method was to measure the carbon dioxide given off by the yeast-sugar mixture under atmospheric conditions, but this method, also, failed because if the solution were disturbed in any way erroneous results were produced.

The third method was to add a few cc. of N/10 alkali to the yeast-sugar mixture, put in an indicator, and determine the time required for the indicator to change color. This method, like the first two, lacked a uniform shaking device and had to be abandoned.

The fourth method was found to be better than the first three, but checking results could not be secured. In this method the yeast, sugar, water, and corn starch were mixed into a thin paste, allowed to stand under set conditions of temperature and time, and the volume of the evolved gas was measured. As a side issue, the pH of the testing solu-

tion was controlled by using a standard acetate buffer solution. The gas evolved was measured on the Chittick baking powder apparatus. It was found that checks could be run on a cake of yeast with a 2% error, which was entirely too high to render the method practical. Because of the slow nature of this work and the pressure of other work, progress has been difficult.

It is recommended that in studying this problem for the coming year, several members, whose chief work deals with yeast entirely, be assigned for committee work. It is believed that this is a major problem in cereal work and worthy of the attention of more than one investigator.

#### Summary

1. Several methods have been tried in an endeavor to develop a standard yeast testing procedure.
2. The best procedure worked out permits an error of 2% between duplicates on the same sample of yeast. This is too large an error to be practical.
3. This work has been only preliminary, and it is recommended that a committee be appointed to study yeast testing.

#### Effect of Individual Molding Upon the Bread Produced by the Standard Experimental Baking Test

G. MOEN

General Mills, Inc., Minneapolis, Minn.

In order to study the effect of individual molding upon bread produced by the Standard Experimental Baking Test, a series of bakes was run in which the only variable was the molding. Persons having more or less experience with this method met in the same laboratory at various times, where doughs had been prepared for them. In all tests, each man molded three doughs and the average results were considered. At times there was considerable variation within triplicates, but usually two loaves would check nicely and sometimes all three. When a loaf was out of line with the other two, it was not considered.

Table I shows the results obtained by individuals A, B, C, and D. External and internal characteristics were scored according to the "Proposed Reporting System for Standard Baking Test," by M. J. Blish in *Cereal Chemistry* vol. 5 pp. 289-296. 1928.

TABLE I

Person	Loaf volume		External type	Internal type
A	435*	413	F	4
	410		J	3
	415		J	4
B	415	413	J	5
	410		J	4
	435*		F	4
C	405	401	J	2
	395		J	4
	405		J	4
D	425	430	J	3
	410*		J	4
	435		J	4

\*Omitted from average.

A and B check reasonably well; D has a tendency to produce a larger volume than the others.

Considerable variation was observed in the way these four men handled the dough. A was experienced with this type of loaf and pounded doughs vigorously. B also was experienced but did not pound doughs very hard, nor did he roll them as tight as A. However, B's results vary slightly from A's. C was inexperienced with this type of loaf. He did not pound his doughs hard or roll them tight. His average volume is the lowest and the grain in one of his triplicates was considerably out of line with the other two. D was experienced in this procedure and handled the doughs more like A than either of the others. However, D pounded the doughs flatter and seemed to spread the dough out more than A. A apparently pounded the doughs just as hard but with more of a vertical motion. Also, D rolled the doughs slightly tighter than A did.

The oven in which these loaves were baked was of the stationary type, built to hold six loaves of this size. However, when one loaf at a time was put in the fluctuation in temperature was so great it was feared that the oven temperature would have as much effect upon the loaves as the individual molding. Consequently, as this laboratory is equipped with a battery of six mixers, built to mix this small dough, it was thought a better study could be made of the effect of molding if two individuals molded three doughs each from a set of six so that all six could go in the oven at the same time. In this way, the doughs would come nearer to receiving the same oven treatment.

Table II shows the results obtained by A and E. Two sets of doughs were run to demonstrate whether or not the differences in the results produced by these two men were consistent. The results given are from machine-mixed doughs, made from a different flour than that reported in Table I.

TABLE II

Individual	Loaf volume	External type	Internal type
First Set			
A	490	G	3
	470	G	3
	430	J	4
E	480	G	2
	455	J	2
	465	G	2
Second Set			
A	475	G	3
	485	G	3
	470	G	3
E	450	J	2
	435	J	2
	465	G	2

E was inexperienced with this type of loaf and rolled the doughs rather loose, altho they were pounded to about the same extent as A's. It will be noted that E's volume is smaller and internal characteristics are coarser than A's in both experiments.

In the next attempt, A, B, and D worked on machine-mixed doughs. The results are given in Table III.

TABLE III

Individual	Loaf volume	External type	Internal type
First Set			
A	490	F	4
	520*	F	4
	495	F—	4
D	515	F	3
	535	F	3
	530	F	3
Second Set			
A	485	F	4
	485	F	4
	465	F	4
D	525	F	3
	505	F—	3
	525	F—	3
Third Set			
A	495	F—	3
	525	F	3
	450	J	4
B	490	F	3
	520	F	3
	470	J	3
Fourth Set			
A	535*	F	4
	490	F—	4—
	485	F—	4
B	455*	J	3
	475	F	3
	485	F	3

\*Omitted from average.

In the first set, in Table III, A and D molded the same as they did in that reported in Table I. In the second set, D tried to follow A's molding as closely as possible. The results show approximately the same variation in both sets. Comparing these results with those obtained by the same two men, in Table I, it will be seen that D quite consistently produced larger volume than A. In Table I no material difference in the grain produced by A and D appears, but Table III shows that A's loaves consistently have a finer grain.

In the third set of Table III, A and B molded the same as they did in Table I, but in the fourth set B tried to follow A's molding as closely as possible. It will be noted that their average results checked well except that A's loaves had a slightly finer grain. Going back to Table I, it will be seen that A and B check quite consistently, altho there was apparently more difference in the molding than between A and D.

The work reported in Table I and Table III was done several weeks apart and on different grades of flour. However, the results from A, B, and D bear approximately the same relation to each other in both experiments.

It cannot be said that all the differences and variations appearing in these four tables can be directly attributed to the molding. However, when average results are considered it appears certain that molding plays a very important part in the results obtained.

### Summary

Five persons asked to mold doughs according to directions given in the standard procedure, exhibited five different ways of molding. Each man followed the number of turns and folds precisely, but varied in regard to vigorous pounding and tight rolling.

Inexperienced or loose molding produced lower volume and coarser grain.

Two experienced operators molding apparently in much the same way consistently produced different results on the same flour in respect to volume and in most cases a noticeable difference in grain.

Two experienced operators, who apparently exhibited considerable difference in manner of molding, produced similar results in volume and internal characteristics.

### Relation of Supplement C to the Other Optional Methods of the Standard Experimental Baking Test

W. L. HEALD

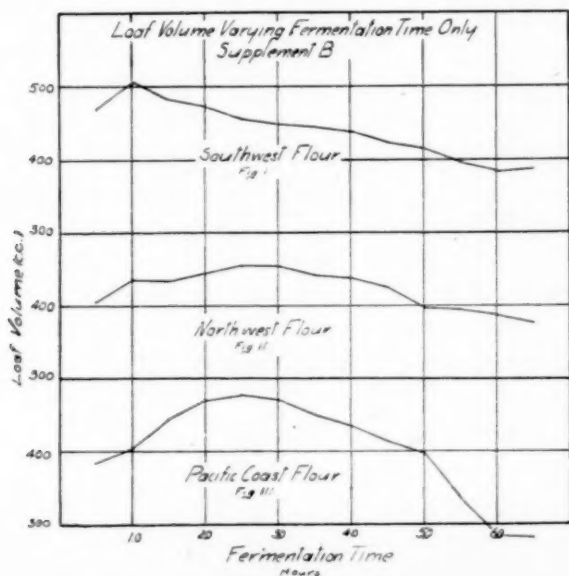
Larabee Flour Mills Co., Kansas City, Mo.

The purpose of this work was to determine and present figures and data on the relation of Supplement C to the other optional methods in the Standard Experimental Baking Test.

Baker's flours were selected representing a Northwest spring wheat flour, a Southwest winter wheat flour, and a Pacific Coast flour. (From what variety of wheat this flour was made, I am not able to say.)

The chemical analyses of these three flours are compared in Table I. The protein content of the Northwest and the Southwest wheats was almost identical, as was the ash content. Both flours were lightly bleached. The Pacific Coast flour, however, was approximately 1% higher in protein and slightly lower in ash. This flour also carried a slight bleach.

Table II is a tabulation of data on the Southwest flour baked according to Supplement B. The fermentation time was varied from  $\frac{1}{2}$  hour to  $6\frac{1}{2}$  hours. Figure 1 shows the volume curve for that flour. It is interesting to note that the shorter fermentations gave young looking loaves, both interior and exterior. On the 3-hour fermenta-





tion there was slight evidence of shelling and as fermentation increased from about 3 hours, the crust gradually became paler.

Table III is a tabulation of data on the Northwest flour baked according to supplement B, again varying the fermentation time from  $\frac{1}{2}$  to  $6\frac{1}{2}$  hours.

Figure 2 shows the volume curve for Northwest flour. This flour gave results quite similar to those with the Southwest flours except that the grain structure was more compact and spherical. The loaf volume was slightly less.

Table IV is likewise a tabulation of data on the Pacific Coast flour, baked according to supplement B with the fermentation time varied from  $\frac{1}{2}$  to  $6\frac{1}{2}$  hours. Figure 3 shows the volume curve. This flour exhibited younger characteristics than any of the three up to  $2\frac{1}{2}$  hours; from  $3\frac{1}{2}$  hours the loaves carried a pronounced shell top, much more so than the bread baked from any of these flours.

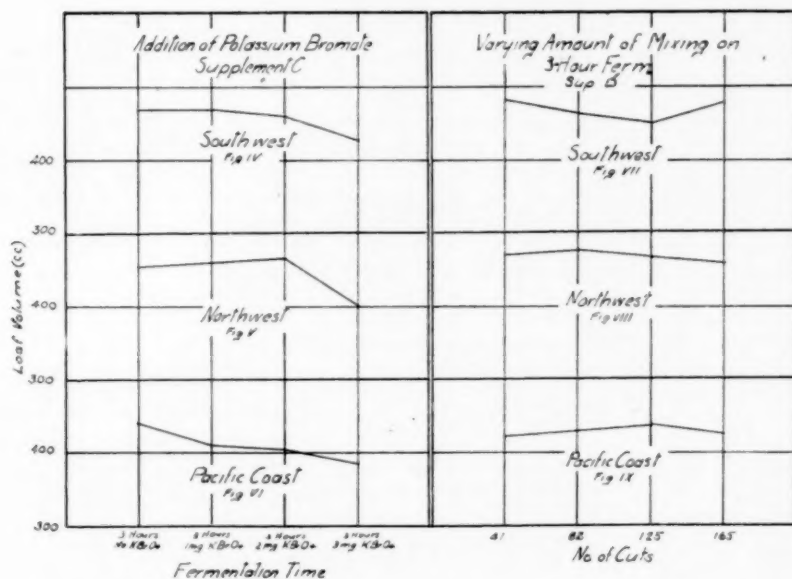
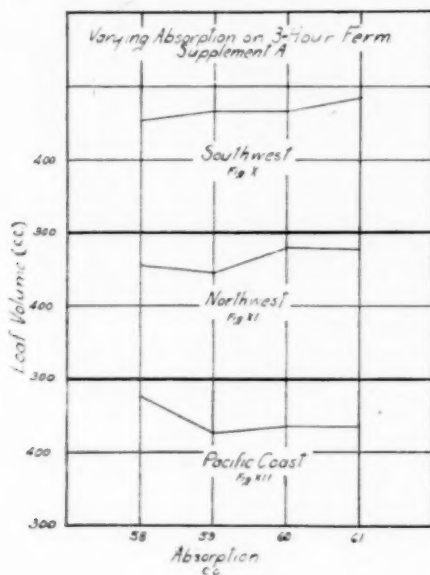


Table V is a tabulation of baking data on the three flours with the addition of potassium bromate, supplement C. The volume curves representing the three flours are shown as Figures 4, 5, and 6 respectively. The general outside characteristics of the loaves were similar with all three flours, there being some difference in the volume. The most noticeable exterior characteristic was that as the bromate increased the paleness of the loaf increased in all cases.

Table VI is a tabulation of baking data on varying amounts of mixing, supplement D. We varied the number of cuts from 41 to 165. Figures 7, 8, and 9, respectively, represent the volume curves. The varying of the mixing did not seem to affect the volume very materially. Texture gradually improved up to 125 cuts; beyond that it was broken down slightly. It was evident that as the mixing increased the shelling decreased.

Table VII is a tabulation of baking data on varying absorption, supplement A. We varied the absorption from 58 cc. to 61 cc. With 61 cc. the dough was almost too slack to handle. Figures 10, 11, and 12 represent the volume curves. With the Southwest and Northwest flours, maximum or near maximum volume was obtained with the greatest absorption. It was noticed, also, that as the absorption increased the evidence of shelling decreased.



The equipment used was as follows: Proof box, an incubator (E. H. Sargent type shelf 18x18 inches inside dimensions), which was checked very carefully to see that the control was within the limits of  $0.5 \pm ^\circ\text{C}$ . The baking oven was a Freas moisture oven with an extra heating unit placed directly above the original unit and a revolving circular shelf, which held four loaves of bread at a time. A small Tycos oven thermometer was fastened in the oven so that it was visible through the glass in the door. The thermometer was placed on a level

with the top of the loaf and about one inch from the pan. The other equipment—mixing bowls, fermentation bowls, and baking pans—were according to specifications as given in *Cereal Chemistry*, vol. 5, p. 161.

It is realized that the data presented are very meager and only represent one flour of each of the three types. Before any general conclusions are drawn, many flours of the types should be baked and the results correlated.

### Summary

1. The relation of supplement C to the optional methods tested in this paper seem to be such that no general relationship may be drawn.
2. The crust color had a tendency toward paleness with each increment of bromate added.
3. As the fermentation increased (supplement B) the evidence of shelling increased.
4. As the mixing increased (supplement D) the evidence of shelling, up to 125 cuts, decreased. Beyond 125 cuts the shelling increased.
5. The increasing absorption produced greatest volume near the greatest absorption, except for the Pacific Coast flour.

### Acknowledgment

The writer is greatly indebted to Mr. Joe Stoklas for conducting the baking tests to which reference is made in this paper.

TABLE I  
ANALYTICAL RESULTS ON FLOURS

At start			At finish	
	Southwest Baker's			
	%	%	%	%
Moisture	12.45	15.00	12.10	15.00
Ash	0.448	0.435	0.448	0.433
Protein	11.01	10.70	11.17	10.80
	Northwest Baker's			
Moisture	11.10	15.00	11.10	15.00
Ash	0.453	0.433	0.450	0.430
Protein	11.17	10.68	11.20	10.72
	Pacific Coast Baker's			
Moisture	10.15	15.00	10.20	15.00
Ash	0.431	0.407	0.433	0.410
Protein	12.65	11.95	12.60	11.91

TABLE II  
SOUTHWEST BAKER'S FLOUR

Fermentation time, hr.	Vol., cc.		Average vol., cc.	Grain structure	Crust color	Crumbs color	General outside character	Remarks
1/2	1	2	470	Sph.*	Very brown	Creamy	Well formed	Inside of loaf very compact
	470	470		99.8				
1	503	508	505	Sph.	Gilbr.	"	"	
	481	486		99.8†				
1 1/2			484	99.9†	"	"	Very well formed	
2	470	476	473	Sph.	"	"	"	
				100				
2 1/2	454	465	459	Sph.	"	"	"	
				100†				
3	449	454	452	Sph.	"	"	Slight evidence of shelling	
				100				
3 1/2	444	449	447	Sph.	"	"	"	
4	438	438	438	100†	"	"	"	
4 1/2	427	427	427	100	"	"	"	
5	411	416	414	100	"	"	"	
5 1/2	390	395	393	99.9†	"	"	Pale and small	As fermentation in- creases, crust be- comes more pale.
6	379	385	383	99.8	"	"	"	
6 1/2	385	390	387	99.8	"	"	"	

\*Spherical.

†Elongated.

TABLE III  
NORTHWEST BAKER'S FLOUR

Fermentation time, hr.	Vol., cc.	Av. vol., cc.	Grain structure	Crust color	Crumb color	Gen. outside character	Remarks
	1	2					
½	406	408	Sph. very open	V. Dark	100 alc.	Very smooth	
			99.8	Gibr.		well formed loaf	
1	444	427	Sph. open	V.	"	"	
			99.9	Gibr.	"	"	
1½	427	438	Sph. very open	"	"	"	
			99.9	"	"	"	
2	438	449	Sl. elong.	"	"	"	
			99.9†	"	"	"	
2½	449	460	Sl. elong.	"	"	Very well formed loaf	Very slight evidence of shelling
			100	"	"		
3	454	454	Sph. sl. elong.	"	"	No evidence of shelling	
			101	"	"	Very slight evidence of shelling	
3½	438	454	Sph. sl. elong.	"	"	Well formed	Shell top
			100†	"	"		
4	433	444	Elong.	"	"	"	The longer the fermentation the more compact the cell structure.
			101	"	"		
4½	422	427	Elong.	"	"	Badly shelled	
			100†	"	"		
5	390	406	V. sph. and fine	"	"	"	
			100	"	"		
5½	395	395	V. sph. and compact	"	"	"	
			100	"	"		
6	385	390	V. sph. and compact	"	"		
			100	"	"		
6½	370	375	V. compact, sph.	"	"	Shell top, well formed, very small	Has sour, yeasty odor.
			100	"	"		

TABLE IV  
PACIFIC COAST BAKER'S FLOUR

Fermen- tation time, hr.	Vol., cc.		Av. vol., cc.	Grain structure	Crust color	Crumb color	Gen. outside character	Remarks	Weight gr.
	1	2			Gibr.	100	Very young		
1½	379	390	385	Sph. 99.8	"	"	Well formed loaf		136
				SL elong.			"		133
1	400	411	406	99.8	"	"	"		134
				SL elong.			Slight evidence of shelling	Texture very com-	129
1½	444	454	449	99.9	"	"	Very well formed	pact	131
				Elong.			"		128
2	454	465	469	100†	"	"	"		130
				Sph. 100			"		129
2½	465	481	473	100	"	"	"	Body firm in	130
				Sph. elong.			"	all fermentation	129
3	481	460	470	100	"	"	"		128
				Sph. sl. elong.			"		129
3½	444	454	449	99.9	"	"	Shell top, undersized		129
				Sph. 99.9			"		130
4	437	433	435	99.9	"	"	"		130
				Sph. 100			Very shelly, undersized		132
4½	411	416	414	100	"	"	"		130
				Sph. sl. elong.			"		131
5	395	395	395	100	"	"	Shell top very shelly		129
				Sph. sl. elong.			"		130
5½	335	340	335	100	"	"	Shelly, undersized		130
				Sph. sl. elong.			"		130
6	290	295	293	100	"	"	"		130
				Sph. sl. elong.			"		130
6½	280	295	282	100	"	"	"		128



TABLE V  
WITH THE ADDITION OF POTASSIUM BROMATE

Fermen- tation time, hr.	Vol. cc.	Av. vol. cc.	Grain structure	Crust color	Crumb color	Gen. outside character	Remarks
PACIFIC COAST FLOUR							
1	2		Sph. elong.			Evidence of shelling	Well formed
3 Reg. 438	444	441	100	Gbr.	100	" " "	" "
3 1cc. bromate 400	422	411	100—	"	"	" " "	" "
3 2cc. bromate 400	411	406	Elong.	"	"	" " "	Yeasty odor Body not as firm as without bromate
3 3cc. bromate 379	390	384	99.8	"	"	Very rough and scaly	
			Elong.	"	"	" " "	
			99.8	"	"	" " "	
SOUTHWEST FLOUR							
3 Reg. 470	470	470	101	Gbr.	100	Bold, well formed	
3 1cc. bromate 470	470	470	101	"	"	" " "	
3 2cc. bromate 460	460	460	100	"	"	Slight evidence of shelling	As the KBrO4 increases the paleness of the loaf increases
3 3cc. bromate 427	427	427	100—	"	"	" " "	
NORTHWEST FLOUR							
3 Reg. 454	454	454	Sph. sl. elong.	Gbr.	100	Very well formed	
			101	"	"	" " "	
			Elong.	"	"	Slight evidence of shelling	
3 1cc. bromate 454	465	460	101	"	"	" " "	
3 2cc. bromate 460	470	465	101	"	"	" " "	
			Elong. cell	"	"	" " "	
3 3cc. bromate 395	406	400	100†	"	"	" " "	

TABLE VI  
VARYING THE AMOUNT OF MIXING ON 3-HOUR FERMENTATION

No. cuts	Vol. cc.	Av. vol. cc.	Grain structure	Crust color	Crumb color	Gen. outside character	Remarks
PACIFIC COAST FLOUR							
1	2		Sph.			Very slight shelling	
41	416	427	100—	Gibr.	100		As mixing increases evidence of shelling decreases
			Sph. open cell struc.				
82	427	427	99.9	"	"	"	"
125	438	438	100—	"	"	"	"
			Sph. open cell struc.				
165	427	416	99.8	"	"	No evidence of shelling	
SOUTHWEST FLOUR							
41	481	481	Sph.				
			99.9	Gibr.	100	Slight evidence of shelling	As mixing increases evidence of shelling decreases
82	470	465	Elong. ali. sph.	"	"	"	"
125	449	454	100 +	"	"	"	"
			Sph. open cell struc.				
165	486	481	99.9	"	"	No evidence of shelling	
			Sph.				
NORTHWEST FLOUR							
41	460	476	99.8	Gibr.	100	Slight evidence of shelling	As mixing increases evidence of shelling decreases
			Sph.				
82	470	481	99.9	"	"	"	"
125	470	465	100—	"	"	"	"
			Sph.				
165	460	460	99.8	"	"	No evidence of shelling Sph. grain structure in all	

TABLE VII  
VARYING THE ABSORPTION ON 3-HOUR FERMENTATION

H <sub>2</sub> O	Vol. cc.	Av. vol. cc.	Grain structure	Crust color	Crumb color	Gen. outside character	Remarks
PACIFIC COAST FLOUR							
cc.			Sph.			Well formed, evidence of shelling	Text compact, firm, as moisture increases evidence of shelling decreases
58	481	460	100	Gibr.	100		
	1	2					
59	421	426	100	"	"	"	"
	421	423	Sph.				
60	433	438	100	"	"	"	"
	433	435	Sl. Sph. mostly elong.				
	433	435	100	"	"	"	"
61	433	438	Sl. Sph. mostly elong.				
	433	435	100	"	"	No evidence of shelling	
SOUTHWEST FLOUR							
58	449	454	100†	Gibr.	100	Bold, well formed, slight evidence of shelling	As absorption increases evidence of shelling decreases
59	476	476	101	"	"	"	
	465	486	Sph.				
60	492	481	101†	"	"	Slight evidence of shelling, bold, well formed	
61	465	481	100†				
NORTHWEST FLOUR							
58	454	454	Sph. Sl. elong.	Gibr.	100	Very slight evidence of shelling	As absorption increases, evidence of shelling decreases
59	438	443	101	"	"	"	
60	476	481	101	"	"	"	
61	465	481	Sl. elong.	"	"	"	
	465	473	101†	"	"	"	

### **A Descriptive Analysis of the Collaborative Baking Tests of 1928-29**

C. G. HARREL

Bakeries Service Corp., Jamaica, N. Y.

At the Omaha convention, in 1927, the baking committee reported very favorably upon some collaborative work conducted by members of the committee. This work was conducted under conditions that were ideal, namely, that all collaborators were assembled in the same laboratory and thus the same yeast and baking apparatus were available. The presence of all collaborators in the same room while the baking tests were conducted is conducive to a minimizing of the personal element. It is understood that the test used at that time was not exactly the same as the one tentatively adopted by our association last year, but the changes have been very slight. A quotation from the report of the committee is as follows: "The work involved, among other items, trials by the individual committee members who obtained remarkably concordant and satisfactory results, even tho most of the operators were attempting the special technic of the procedure for the first time." Results of this work are very gratifying, in that they prove that under fixed conditions and with the personal element somewhat minimized, the test was exceedingly promising.

Two years have passed since this work was reported. During this interval, many members of our association have familiarized themselves with the Standard Experimental Baking Test tentatively adopted by our association in 1928, at the convention in Minneapolis. Prior to this time, the details of the test were sufficiently well known to permit some laboratories to become familiar with its requirements. It was therefore thought advisable to conduct collaborative work this year for two distinct reasons.

1. To ascertain how closely laboratories would agree, using the Standard Experimental Baking Test as tentatively adopted.

2. By a study of the results obtained, the committee could make any additions or corrections to the test that were necessary for its further development. In a like manner the individual laboratory, by a close analysis, might discover factors causing great discrepancies.

Three collaborative samples were sent out. Sample 1 was to be baked by the basic procedure; sample 2, first by the basic procedure and second, by Supplement C, using 1 mg. of potassium bromate; sample 3, first by the basic procedure and second by Supplement B, using

4 hours fermentation. In each case it was urged that as many as five replicate bakes be made, if possible. Gas production on one of the doughs made by the basic procedure up to the beginning of the first punch was to be measured and reported. One of the loaves representing the average of the bake was mailed to me, with all the data obtained. Having all the loaves together, a more thoro study of the comparative results was possible.

This report will be divided into two distinct parts:

1. A descriptive analysis from a comparative study of the bread.
2. A statistical analysis of the data will be presented by C. H.

Bailey.

In presenting the descriptive analysis, lantern slides have been prepared to bring the results to you more clearly. The image of the interior of the bread as shown on the screen has been enlarged approximately five times. If no enlargement had been made, it would have been very difficult for persons in the audience, at some distance from the screen, to observe differences in the grain. This enlargement may be somewhat confusing at first, but it serves admirably for a comparative study of the grain produced by the basic procedure and that produced by Supplement C or B.

Before starting a description of the three samples, the six standard types, as published in Cereal Chemistry, vol. 5, pp. 292-294, will be reviewed.

Type F	.....	Slide F
" G	.....	" G
" H	.....	" H
" I	.....	" I
" J	.....	" J
" K	.....	" K

Type K was the only standard type not obtained on any of the loaves sent to me.

The classification as to external type will be given.

Considerable difficulty has arisen in making use of the standard internal types as published in Cereal Chemistry. Consequently, the report of internal resemblance will not be given. For comparative difference, the lantern slides will be relied upon.

#### Collaborative Sample No. 1

This sample was made from a flour having the following analysis on a 15% moisture basis: Ash, 39, protein, 10.80.

The number given, preceding the description, refers to the collaborator's serial number, which remains the same for the three samples.

No. 3 (2),<sup>1</sup> Distinctly type F, volume 453 cc. The only loaf of this type received. Top crust brown, sides white.

No. 4 (3), type G, volume 386 cc. Crust pale white, having the appearance of being very old. Three other collaborators' loaves resembled this in shape but had a brown crust.

No. 6 (4), type H, volume 439 cc. Crust of top light brown. Sides very pale. Four other collaborators had similar loaves.

No. 8 (5), type GF, volume 570 cc. Crust brown. Appearance very rough and ragged. A peculiar loaf.

No. 12 (6), volume 549 cc. Resembles no standard type. Break shown on side was on both sides. Resembles a commercial loaf. Top burned, sides light brown.

No. 15 (7), type J, volume 394 cc. Crust mottled. Exceedingly distinctive markings on side.

No. 19 (8), type J, volume 450 cc. Brown crust, uniform on entire loaf. One other collaborator sent a similar loaf.

No. 26 (9), type G, volume 452 cc. Crust very brown.

No. 28 (10), type J, volume not measured. Light brown crust. Underbaked sides.

No. 29 (11), type HG, volume 528 cc. Crust uniform brown. Six collaborators sent loaves similar to this.

Some of the reported differences in volume are no doubt due to the use of volume boxes not properly calibrated. However, there was a large variation in volume of the loaves (12).

An idea of this difference is obtained by inspection of this slide. The slice in front is taken from the center of one of the smaller loaves; in the background is shown one of the larger loaves. The loaf in the rear is approximately 3 cm. higher than the one represented by the slice. This difference in height represents a volume difference of 150 cc. It must be borne in mind that this citation is not the maximum difference reported by the collaborators. About half the loaves had very smooth sides (13); others were exceedingly rough and ragged with many crater-like holes (14). It is observed that there were considerable variations in the appearance of the loaves.

We shall now turn our attention to the interior. Ten interiors had exceedingly soft texture with a very fine round cell, or grain (15). Six interiors were very similar to the ten just reported (17). The grain was slightly more open. In direct contrast to the round cell

<sup>1</sup>Numbers in parentheses refer to the numbers of the lantern slides.

The lantern slides that accompany this descriptive analysis are in the author's possession. Their use may be obtained by association members or local sections by writing me.



grain (18), five of the interiors had a very irregular cell structure with a somewhat harsh texture. In still greater contrast (16), were two interiors with large, irregular grain cells. The texture was very rough. In fact, the internal appearance was that of a loaf having been greatly overproofed. As a summary of the interior characteristics, sixteen collaborators obtained a round cell or grain with a very close resemblance; the other seven had an irregular grain with a harsh texture.

#### Collaborative Sample No. 2

This sample of flour had the following analysis:

	%
Ash . . . . .	0.37
Protein . . . . .	11.68
Moisture . . . . .	13.81

A thoro study of this flour was made regarding the effect of increments in fermentation period and potassium bromate, respectively. These slides are not enlarged.

Baking this sample (2) by the basic procedure, an average volume of 515 cc. was obtained. By a close inspection of the slide the changes in break, fill in, texture, etc., can be observed as fermentation period is increased. With  $3\frac{1}{2}$  hours fermentation (3), the volume was 505 cc. The break at the top was slightly more ragged and the corners somewhat round;  $4\frac{1}{2}$  hours gave a volume of 470 cc. (4). The grain and texture stood up well under the increased fermentation. With  $5\frac{1}{2}$  hours the volume was 450 cc. (5), the loaf resembling type H. The corners of the loaf are very round. Here you have a comparison of the interior of the 3-hour fermentation (left) and the  $5\frac{1}{2}$ -hour fermentation (right) (6). Another view (7) is of the same loaf cut crosswise. In this series there was a gradual decrease in volume, the grain and texture showing very slight changes.

Our attention is now turned to a study of the flour with Supplement C. The fermentation time is constant, and successive increments of one mg. of potassium bromate are introduced. With one mg. of bromate (8), the volume is 502 cc. Corners are slightly rounded. With 2 mg. of bromate (9), a volume of 470 cc. is obtained. The loaf characteristics are well shown by the slide. With 3 mg. of bromate (10), the volume is 430 cc. Peculiar markings on the side and very round corners and edges are much in evidence. Four mg. of bromate (11), gave a volume of 422 cc., with a very peculiar loaf. Note the appearance of the sides carefully, as a few of the loaves sent in resemble it so closely that I am sure you will at once notice the similarity. This is a comparison (12) of the interiors from the basic procedure (left) and

with 3 mg. of bromate (right). Here is another view of the same comparison (13). There has been a large decrease in volume. The grain has opened some, but considering that 3 mg. of bromate was used, it has stood up remarkably well. The results are graphically presented (1). The volume is plotted along the ordinate; the abscissa is employed for the fermentation periods and bromate quantities, respectively. The upper straight line volume time curve indicates that the flour is of a negative nature with respect to increased fermentation. The volume bromate curve shows clearly the behavior of the flour to increments in bromate with regard to volume only. These results have been shown, not that any generalizations should be drawn, but that the characteristics of this flour might be observed before reviewing the individual collaborative work.

We shall now turn our attention to a study of the individual results. In the slides presented, the half of the loaf next to the ruler, on the left, is produced by the supplement in question; the loaf on the right is made by the basic procedure. It is absolutely necessary that this be constantly kept in mind to receive any value from the lantern slides. I will repeat—the half loaf on the left side, next to the scale, in both exterior and interior views, is produced by the supplement in question; the half loaf on the right in both exterior and interior views is from the basic procedure.

No. 1 (19)

Volume on basic procedure 440 cc. Supplement C gave a decrease of 25 cc.; type J loaf. Light brown crust (20). Interior crumb color considerably darker with Supplement C. Grain slightly more open.

No. 2 (21)

Volume on basic loaf 481 cc., type G. One mg. bromate gave 11 cc. decrease in volume and a type J loaf. Interior, crumb color whiter with elongated cell structure with Supplement C (22). The basic procedure gave round cell structure.

No. 3 (23)

Basic, type GH loaf, volume 462 cc. Supplement C produced type GI loaf with an increase in volume of 30 cc. This is one of the few loaves that had a larger volume with Supplement C. Interior, Supplement C (24) produces slightly finer grain with whiter crumb.

No. 4 (25)

Basic, type GF loaf, volume 441 cc. Supplement C gave a decrease in volume of 2 cc. with type FG loaf. Both loaves

have pale crust. Interior (26), little difference in color, Supplement C giving slightly more open grain.

No. 5 (27)

Basic, type GH loaf, volume 589 cc. Supplement C gave type GI loaf with decrease in volume of 53 cc. Interior (28), Supplement C produced slightly more open grain with an irregular cell; the basic procedure produced a round cell. Little difference in color.

No. 6 (29)

Basic, type FG loaf, volume 567 cc. Supplement C produced 2 cc. decrease in volume and type G loaf. Crust light brown. Interior (30), Supplement C produced slightly more open grain. Little difference in crumb color.

No. 7 (31)

Basic, type F loaf, volume 498 cc. Supplement C gave type F loaf with decrease in volume of 48 cc. Interior (32), Supplement C produced a slightly more open grain. Irregular cell structure compared with round cell structure produced by basic procedure. Little difference in color.

No. 9 (33)

Basic, type H loaf, volume 401 cc. Supplement C gave an increase in volume of 28 cc. with type J loaf. This is the second collaborator who obtained an increase in volume by use of Supplement C. Top crust of both loaves is badly burned. Interior (34) shows little difference between basic procedure and Supplement C.

No. 11 (35)

Basic, type GH loaf, volume 495 cc. Supplement C produced type GH loaf with an increase in volume of 2 cc. A third case of increase in volume with Supplement C. Interior (36), Supplement C produced slightly more open grain. Little difference in color or shape of cells.

No. 14 (39)

Basic, type GH loaf, volume 578 cc. Supplement C produced 40 cc. less volume with type GH loaf. Interior (40), Supplement C produced slightly more open grain with whiter crumb.

No. 15 (41)

Basic, type JF loaf, volume 436 cc. Supplement C gave decrease in volume of 38 cc., with type J loaf. Crust color slightly mottled grayish brown in appearance. Very peculiar

markings on sides of loaf. Interior (42), Supplement C gave slightly more open grain with little difference in crumb color or texture.

No. 16 (43)

Basic, type J loaf, volume 501 cc. Supplement C gave 9 cc. less volume, with type J loaf. Crust color of loaf from Supplement C considerably browner than that of basic loaf. Interior (44), Supplement C produced a slightly more open grain. Little difference in crumb color.

No. 18 (45)

Basic, type F loaf, volume 482 cc. Supplement C gave decrease in volume of 31 cc., with type GH loaf. Crust of both loaves very brown. Interior (46), shows little difference with reference to color, grain, texture, or cell structure.

No. 19 (47)

Basic, type G loaf, volume 496 cc. Supplement C gave 55 cc. less volume, with type GF loaf, having browner crust than loaf of basic procedure. Interior (48), Supplement C produced distinctly whiter crumb, with little difference in texture or grain.

No. 20 (49)

Basic, type GK loaf, volume 520 cc. A very peculiar loaf. This collaborator's work was somewhat interesting and the entire loaf was photographed. The sides of the loaf give the impression that it is very old. Supplement C (49a) gave a decrease in volume of 65 cc. and produced a loaf that is certainly distinctive. After some consultation among the type specialists, this loaf was referred to the Museum of Natural History for classification. The loaf undoubtedly shows signs of great age. Just how this was produced, we are unable to tell; possibly by an excess of bromate, a high temperature, or an abnormal yeast supply. Interior (50), the peculiar shaped loaf produced by Supplement C had a very dark crumb; the basic procedure had the appearance of normal bread in texture, color, and grain. There is undoubtedly some factor influencing the results obtained by this collaborator.

No. 21 (51)

Basic, type F loaf, volume 511 cc. Supplement C gave a decrease in volume of 13 cc. with a type F loaf and a lighter crust color. Interior photograph was not obtained.

## No. 23 (53)

Basic, type H loaf, volume 482 cc. Supplement C gave type J loaf with a decrease in volume of 44 cc. Interior (54), Supplement C produced more open grain with whiter color and little difference in texture.

## No. 25 (55)

Basic, type H loaf, volume 519 cc. Supplement C gave 21 cc. less volume and type J loaf. Crust of both loaves very brown. Interior (56), no difference between Supplement C and basic loaf.

## No. 26 (57)

Basic, type HG, volume 505 cc. Supplement C gave type HG loaf 24 cc. less volume. Interior (58), very peculiar cell structure with little difference between Supplement C and basic loaf.

## No. 27 (59)

Basic, type G loaf, volume 450 cc. Supplement C gave a type HI loaf, with a decrease in volume of 95 cc. This is the greatest decrease in volume obtained in this series. Sides and top very brown. Interior (60), Supplement C produced whiter crumb with finer grain and better texture.

## No. 28 (61)

Basic, type J loaf, volume 506 cc. Supplement C gave 12 cc. less volume with type J loaf. Interior (62), an elongated cell structure with slightly whiter crumb color was given by Supplement C, otherwise little difference.

## No. 29 (63)

Basic, type GF loaf, volume 519 cc. Supplement C gave type GF loaf and an increase of 36 cc. in volume. This is the fourth example with an increase in volume by use of Supplement C. Interior (64), no difference in texture, color, or grain.

Summarizing the results of the second collaborative sample, we find:

1. There is a considerable variation in loaf volume between laboratories.

2. The type of loaf obtained by the various collaborators varied greatly.

3. Four collaborators obtained an increase in volume with Supplement C, using 1 mg. of potassium bromate. Seventeen obtained a decrease in volume.

4. Six collaborators obtained the same interiors by both the basic procedure and Supplement C. Two had interiors with a fine grain by the use of Supplement C. Twelve obtained grains slightly more open with inferior texture when Supplement C was used.

#### Collaborative Sample No. 3

This sample had the following analysis on a 15% moisture basis.

Ash .....	% 0.41
Protein .....	11.35

This was to be baked (1) by the basic procedure and (2) by the use of Supplement B, using a 4-hour fermentation period. The findings of the collaborators will be presented.

No. 1 (65)

Basic, type J loaf, volume 440 cc. Supplement B gave a decrease in volume of 25 cc. with a similar type loaf. Both loaves had straw-colored crust.

No. 2 (67)

Basic, type F loaf, volume 456 cc. Supplement B gave type F loaf with 2 cc. increase in volume. Crust light brown. Interior (68), Supplement B produced a darker crumb with considerably finer grain.

No. 3 (69)

Basic, type F loaf, volume 435 cc. Supplement B produced a decrease in volume of 7 cc. and similar type of loaf. Crust very brown. Notice peculiar markings along side of loaf. Interior (70), Supplement B gave slightly duller crumb with slightly finer grain.

No. 4 (71)

Type H loaf, volume 385 cc. Supplement B gave an increase in volume of 4 cc. and type H loaf. Crust pale, almost white. No difference between 3- and 4-hour fermentation. Interior (72), Supplement B produced crumb considerably darker with grain slightly more open.

No. 5 (73)

Basic, type HG loaf, volume 503 cc. Supplement B gave 20 cc. increase in volume with similar type loaf. Crust light brown. Interior (74), no difference in texture, grain, or color.

No. 6 (75)

Basic, type H loaf, volume 508 cc. Supplement B gave 8 cc. decrease in volume and type H loaf. Crust of both loaves



a good brown. Interior (76), little difference in texture, grain, or color.

No. 7 (77)

Basic, type F loaf, volume 444 cc. Supplement B gave 23 cc. decrease in volume, with type H loaf and lighter crust color. Interior (78), Supplement B gave darker crumb. No difference in texture or grain.

No. 9 (79)

Basic, type J loaf, volume 474 cc. Supplement B gave 21 cc. less volume with type FH loaf. Notice great contrast between No. 4, with its white crust, and this collaborator's loaves. These loaves have top crusts that are badly burned. The crust on the side of the loaf with 4 hours fermentation is lighter than that of the loaf from basic procedure. Interior (80), crumb color of Supplement B a little darker with slightly finer grain.

No. 10 (97)

Basic, type FJ loaf, volume 515 cc. Very peculiar shaped loaf. Crust light brown. Supplement B gives 3 cc. decrease in volume and type FJ loaf. (97A) Crust brown, loaf very peculiar shape. We believe that a pan of improper size was used by this collaborator. No internal description was obtained.

No. 11 (81)

Basic, type G loaf, volume 444 cc. Supplement B gave an increase in volume of 16 cc. and a type H loaf. This increase is not observed by an inspection of the slide. On the contrary, the slide would lead us to believe that Supplement B produced a smaller loaf. Crust color of loaf from Supplement B lighter than loaf from basic procedure. Interior (82), both loaves have exceedingly fine grain. Supplement B has slightly closer grain.

No. 12 (83)

Basic, type JH loaf. Supplement B gave type H loaf. No volume reported. Both loaves have burned top crust. Interior (84), Supplement B gave more open grain; little difference in color.

No. 14 (85)

Basic, type G loaf, volume 483 cc. Supplement B gave 8 cc. decrease in volume with type GH loaf. Crust brown. Interior (86), Supplement B produced closer grain with little difference in color or texture.



## No. 15 (87)

Basic, type JH loaf, volume 377 cc. Supplement B gave 6 cc. decrease in volume with type JH loaf. Crust grayish brown on both loaves. Interior (88), little difference in texture, grain, or color.

## No. 17 (89)

Basic, type F loaf, volume 433 cc. Supplement B gave increase in volume of 11 cc. and type GH loaf. Crust of basic browner than that of Supplement B. Interior (90), disregarding large holes in Supplement B, there is little difference in texture, grain, or color.

## No. 18 (91)

Basic, type H loaf, volume 426 cc. Supplement B produced 20 cc. less volume, and type H loaf. Crust of both loaves very brown, that of Supplement B slightly browner than the basic. Interior (92), Supplement B gave closer grain.

## No. 19 (93)

Basic, type JF, volume 420 cc. Supplement B gave 28 cc. less volume with lighter crust color and type J loaf. Interior (94), little difference in texture, grain, or color.

## No. 20 (95)

Basic, type JF loaf, volume 485 cc. Supplement B produced 47 cc. less volume with similar loaf. Both loaves have practically the same crust color. Interior (96), Supplement B had slightly darker crumb with finer grain.

## No. 21 (99)

Basic, type FH loaf, volume 421 cc. Supplement B produced type FG loaf with an increase in volume of 19 cc. and a crust considerably lighter than that of the basic loaf. Interior (100), Supplement B gave much finer grain and better texture.

## No. 22 (101)

Basic, type HG loaf, volume 492 cc. Supplement B gave 16 cc. decrease in volume with pale crust on type H loaf. Interior (102), little difference in color, texture, and grain between Supplement B and basic.

## No. 23 (103)

Basic, type J loaf, volume 503 cc. Supplement B gave 17 cc. decrease in volume with type F loaf. Crust of Supplement B loaf browner than loaf from basic. Interior (104), Supplement B gave slightly finer grain. No difference in texture or crumb color.

## No. 24 (105)

Basic, type J loaf, volume 511 cc. Supplement B gave an increase in volume of one cc. with type J loaf. Crust color of Supplement B lighter than basic, altho both were very brown. Interior (106), little difference between the two loaves in color, texture, and grain.

## No. 25 (107)

Basic, type H loaf, volume 481 cc. Supplement B gave 44 cc. decrease in volume with type H loaf, having much paler crust than basic loaf. Interior (108), grain of Supplement B slightly finer.

## No. 26 (109)

Basic, type HG loaf, volume 465 cc. Supplement B gave 4 cc. decrease in volume and type H loaf. Crust color of Supplement B little different from that of basic. Interior (110), Supplement B produced much darker crumb with slightly finer grain.

## No. 28 (111)

Basic, type G loaf, volume 540 cc. Supplement B gave type JF loaf with 45 cc. decrease in volume. Note that the 4-hour loaf has browner crust. I am sure this is due to oven conditions, as this collaborator has found his oven unsatisfactory throughout his investigations. It is interesting to note how smooth the sides of the loaves are in comparison with some of the very rough ones to which I previously called your attention. Interior (112), Supplement B gave a darker crumb and finer grain.

## No. 29 (113)

Basic, type FG loaf, volume 458 cc. Supplement B gave an increase in volume of 3 cc. with type H loaf. Little difference in crust color. Interior (114), Supplement B produced a finer grain.

In summarizing the results of Sample No. 3, we find:

1. Nine collaborators obtained an increase in volume, while 16 obtained decreases in volume with an increment in fermentation of one hour.
2. Twelve collaborators obtained finer grain and two a more open grain. The others obtained no difference in grain from the use of Supplement B.
3. Seven loaves had crumb considerably darker when Supplement B was used; in the other loaves there was no difference.

**Statistical Analysis of Certain of the Collaborative Baking Tests**

C. H. BAILEY

Division of Agricultural Biochemistry, University of Minnesota,  
St. Paul, Minnesota

There are three sets of baking tests. The first set involved the basic procedure. In this set the coefficient of variation of the loaf volume was  $CV_x = 8.76\%$ , the coefficient of variation of gas evolved, in cc., was  $CV_z = 25.67\%$ . The coefficient of correlation of loaf volume (x) and gas evolved (z) was  $r_{xz} = +0.22 \pm 0.13$ . This is not significant.

In the second series of collaborative baking trials the basic procedure was compared with the bromate differential test. The coefficient of variation of the basic procedure loaf volume (y) was  $CV_y = 7.69\%$ . The same constant in the instance of bromate loaf volume was  $CV_x = 10.26\%$ . The coefficient of correlation of the loaf volume in these two baking tests was  $r_{xy} = +0.81 \pm 0.05$ . The coefficient of correlation of the basic test loaf volume (y) with the gas volume (z) was  $r_{yz} = +0.13 \pm 0.14$ , which is not significant. The coefficient of variation of the gas volume data was  $CV = 30.03\%$ .

In the third series of baking tests, the basic procedure, loaf volume (x) was compared with the loaf volume after adjustment of fermentation time (y). The coefficients of variation were  $CV_x = 8.1\%$ ,  $CV_y = 8.83\%$ . The coefficient of correlation of the two sets of baking tests was  $r_{xy} = +0.81 \pm 0.04$ . The correlation of basic loaf volume (x) and gas volume (z) in this series was  $r_{xz} = -0.23 \pm 0.13$ . In this instance the correlation was negative, but again it was not significant when considered in terms of the large probable error.

In general there was a large positive correlation between the results of the tests by the basic procedure in terms of loaf volume and the tests made by addition of bromate or by adjustment of fermentation time.

**Ovens**

C. G. HARREL AND J. H. LANNING

Bakeries Service Corporation  
Jamaica, N. Y.

Before presenting this paper, the following statements are desirable:

1. As an activity of the baking committee, it must be distinctly understood that it is not the function of this work to recommend any specific type of oven.

2. The baking committee and the association are vitally interested in the various ovens now on the market. These data were collected in a scientific manner and are here impartially presented.

3. By such investigation, it is believed that the baking committee will be assisted in making further oven specifications.

Many thanks are due to the Despatch Oven Company and the Freas Thermo-Electric Company for their assistance in making this work possible. Both have spent time and money in the furtherance of these tests. The following type ovens have been tested this year:

Oven M, requiring 110 volts and a wattage of 3500, with a revolving shelf and a forced draft.

Oven O, 110 volts, wattage 2500, natural draft, with a planetary system of rotation known as Model No. 155.

Oven L, 110 volts, wattage 2750, natural draft, with a rotating shelf known as Model No. 150.

In designing, constructing, or purchasing ovens that will properly perform the work contemplated, it is necessary that the problem be defined as accurately as possible in the form of a standard specification, made to embody not only the physical factors but also the economic factors. The latter are of considerable interest to cereal chemists, that is, it is necessary to consider (1) the physical laws involved in the process to be carried out; and (2) the cost of constructing the ovens so that they may be properly designed in accordance with the physical laws and structural limitations and yet have a price that is within the means of the average laboratory.

Baking, defined as far as our present knowledge will permit, is an operation in which certain physical and chemical changes take place when heat is supplied properly. It is important that the supply of heat must not be confused with heat intensity or temperature. Temperature is merely an indication of heat level and in itself does not completely define the quantity of heat present. The temperature of different bodies only indicates the direction in which the heat transfer will take place. It is an indication of potential energy, just as is the height of a waterfall, but likewise it does not define the available energy. The total energy, or heat involved, is dependent on the total mass of material at the high temperature and its capacity is generally defined as its specific heat. In all problems involving a heat transfer, the temperature actually attained by the cold body will be dependent on the total quantity of heat delivered, its own specific heat, its own mass, and any heat required for physical and chemical changes of state. The hot body will likewise lose temperature in a degree dependent on the same factors.

An oven may be defined as a chamber in which materials are artificially heated in an air medium. The air occupying the space between the heat source and the dough is nothing more or less than an intervening medium across which the heat must be transmitted. Other mediums for heat transfer could be employed, altho this would be accompanied by undesirable factors.

Heat may be transferred in three ways: By conduction, by radiation, and by convection. Conduction is internal and consists in transfer by the motion of the molecules. Radiation is the transmission of heat through space by wave motion, the energy of the wave being partially converted into heat on striking a heat-absorbing surface. The quantity of heat transferred by radiation is set forth by the Stefan-Boltzmann law as follows:

B.T.U. per hours radiated per square foot by a black body =  $16 \times 10^{-10} (T^4 - T_o^4)$ ; where  $T$  = absolute temperature in °F. of a black radiating body,  $T_o$  = absolute temperature in °F. of the receiving body.

From this formula and by the substitution of proper values for non-black bodies, at low temperatures and with comparatively small temperature differentials the transfer of heat by radiation is negligible.

Convection is the transfer of heat by the absorption of it by an intermediate substance, which conveys it to another body by suffering a physical displacement. For example: If a brick is placed in fire and withdrawn when hot and placed in a bucket of water, convection has been employed to transmit the heat of the fire to the water.

The internal conductivity of air is small, about 1/10000 that of silver, so in an oven comparatively little heat will be transferred across the intervening air medium by internal conduction. Likewise, as the temperature of both the air and the heat source is comparatively low, and the differential between them is not great, the transfer of heat by radiation may be considered negligible. This leaves available only the transfer of heat by convection as the method obtained in an oven. Convection may occur by natural means or it may be hastened by employing forced draft. This leads to a classification of ovens into four distinct groups:

1. Ovens without rotating shelves or forced draft.
2. Ovens with rotating shelves but without a forced draft other than that caused by the rotation of the shelf.
3. Ovens with forced draft but without a rotating shelf.
4. Ovens with forced draft and rotating shelves.

The specifications for baking as published in Cereal Chemistry, vol. 5, p. 160, read as follows: "Bake 25 minutes at temperature of

230°C. (plus or minus 2) at the level of top of baking pan. Precise control of temperature as to both degree and uniformity is essential." This specification under close examination is not as rigid as it might at first seem. It merely states that the temperature is to be taken at some point that is on a plane level with the top of the pan. The thermometer or pyrometer might be placed 10 inches away from the loaves being baked. This would show an entirely different temperature variation from one placed 2 inches from the top of the pan in the same plane. Again, it would be entirely possible for a thermometer to be placed in a plane level with the top of the pan and on the side of the pan nearest the oven walls. In such a case, the oven walls would probably exert as much influence on the thermometer as the bread.

In fact, with specifications permitting many interpretations, it is entirely possible to so place a thermometer that an excellent oven may show very poor results. In a like manner, a thermometer or pyrometer could be placed, in exact accordance with the specifications, so that a poor oven would actually show very small temperature variations. Such were the specifications under which we have worked for the last year.

Before attempting work on the testing of ovens, it was essential that the temperature-recording device be placed at some fixed point in the plane level with the top of the pan. The committee agreed, at Chicago, that the specifications should read, "Bake 25 minutes at a temperature of 230°C. (plus or minus 2) at level of top of baking pan, 5.09 cm. distant from the pan on the side next to the axis of rotation."

The investigations undertaken this year have been made in accordance with the specifications just given. These specifications are somewhat more definite but are not yet complete. They specify only the temperature and nothing in regard to the quantity of heat delivered. It is believed that the specifications would be far more definite and useful if, in addition to stating the heat potential or temperature, the quantity of heat delivered be specified, i.e., the number of calories or B. T. U.'s delivered per minute. There may be some difficulty in procuring such a specification because of the large number of factors involved in the baking of bread about which little is known. However, such a specification is entirely possible.

In collaborative work where baking temperatures of 230°C. are used, some may use natural-draft ovens while others use forced-draft ovens, the same baking results cannot be expected, especially in respect to crust color. The quantity of heat delivered per unit of time



must be considered if the baking test is to keep step with the progressive methods that have been developed for color determination.

In temperature measurements, copper constantan thermocouples were employed. The diameter of the copper wire was 0.25 mm. while for the constantan, the diameter was 0.66 mm. No metallic cap or housing was placed over the element. The wires composing this couple were of small dimensions and, placed in the oven without any covering, gave an almost instant response to a change in temperature. The copper constantan thermocouples were properly calibrated. The cold junction of the thermocouples was kept at a temperature of 0°C. A Type K Leeds and Northrup potentiometer was used in measuring the E.M.F. The six copper constantan couples used were compared with a thermometer and after applying the proper corrections for the thermometer, a close agreement was found. The pans were spaced equidistant on their circumference of rotation, so that a line drawn from the center of rotation was perpendicular to the midpoint of the length of the pan. The thermocouples were placed on these perpendicular lines 5.09 cm. from their mid points between the pans and the center of rotation and in a plane level with the top of the pan.

In all bakings conducted, the basic procedure of the Standard Experimental Baking Test was employed. Five phases of investigation were undertaken, as follows:

1. The temperature time relation was studied after an hour had elapsed from the time of turning on the current.
2. The drop in temperature when the doors of the ovens were opened was investigated at 5-minute intervals up to 30 minutes.
3. Temperature changes at various distances from the loaves were noted in both a natural-draft and a forced-draft oven.
4. The temperature variation under load capacities of two, four, six, and eight loaves, if the oven capacity permitted the last, at time intervals as nearly the same as possible over the baking period, was investigated.
5. Changes in crust color and baking characteristics were observed.

The thermostats were adjusted to give a temperature of 230°C. and were regulated to respond to the minimum temperature change of which they were capable. The vents of all ovens were closed. Without any load, oven M required 35 minutes; oven O, 60 minutes; and oven L, 55 minutes to reach a temperature of 230°C. After 60 minutes had elapsed from the time of turning on the current, the temperatures were read at the time intervals shown in Table I for



oven M, Table II for oven O, and Table III for oven L. These tables give the readings for each thermocouple, placed as previously described. The average reading of these six thermocouples was taken as the oven temperature. This is plotted in Figure 1 for each of the ovens. Ovens M and L have been somewhat favored by the time unit chosen, as their wattage was considerably higher than that of oven O. This, no doubt, accounts for the slightly irregular curve as given by oven O, which probably would have become more regular if a period longer than one hour before taking the readings had been chosen.

TABLE I

TEMPERATURES OF OVEN M AT VARIOUS-TIME INTERVALS AFTER A HEATING PERIOD OF 60 MINUTES

Time interval, min.	Temperature of thermocouples, °C.						Average oven temperature, °C.	Maximum variation in oven temperature, °C.
	1	2	3	4	5	6		
0	229	227	234	233	232	235	231.7	8
5	228	227	235	232	232	234	231.3	8
10	230	226	236	231	231	235	231.5	10
15	228	227	235	231	231	237	231.5	10
20	227	227	233	231	231	234	230.5	7
30	229	225	233	233	231	236	231.2	11
40	228	226	233	231	230	236	230.7	10

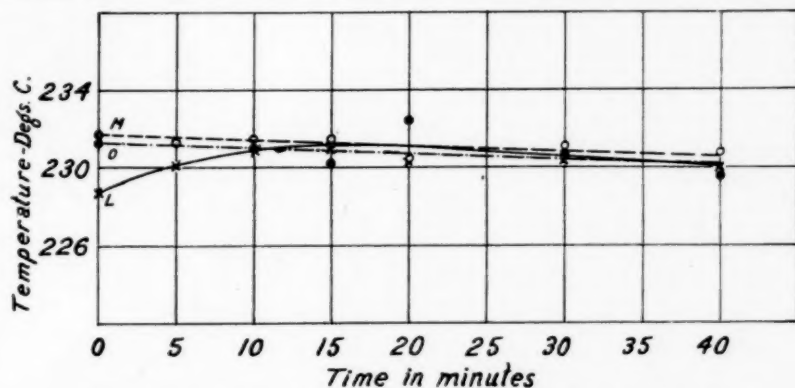


Fig. 1. Temperatures of Ovens After a Heating Period of 60 Minutes

TABLE II

TEMPERATURES OF OVEN O AT VARIOUS TIME INTERVALS AFTER A HEATING PERIOD OF 60 MINUTES

Time interval, min.	Temperature of thermocouples, °C.						Average oven temperature, °C.	Maximum variation of oven temperature, °C.
	1	2	3	4	5	6		
0	233	232	232	231	230	230	231.3	3
5	235	232	232	231	229	229	231.3	6
10	228	230	233	229	233	233	231.0	5
15	232	230	230	231	230	229	230.3	3
20	233	233	233	234	232	230	232.5	4
30	232	231	231	232	231	230	230.8	2
40	230	229	230	230	230	228	229.5	2

TABLE III

TEMPERATURES OF OVEN L AT VARIOUS TIME INTERVALS AFTER A HEATING PERIOD OF 60 MINUTES

Time interval, min.	Temperature of thermocouples, °C.						Average oven temperature, °C.	Maximum variation in oven temperature, °C.
	1	2	3	4	5	6		
0	230	226	228	230	228	230	228.8	4
5	229	227	226	233	232	234	230.2	8
10	232	229	228	230	232	235	231.0	7
15	232	229	229	234	232	231	231.2	5
20	229	226	228	236	233	231	230.5	8
30	234	230	230	229	227	233	230.5	7
40	231	232	231	229	227	230	230.0	5

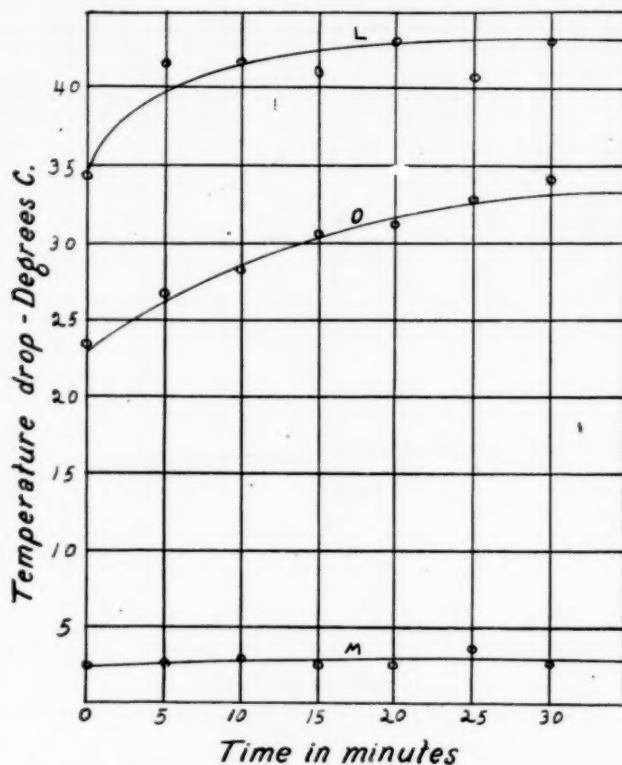


Fig. 2. Temperature-Time Curves with Oven Doors Opened

The tests just described required one hour and 40 minutes. The door of each oven was then opened for 30 minutes. Temperature readings were taken at 5-minute intervals. The temperature at each of these intervals was subtracted from the oven temperatures recorded by the respective thermocouples at the end of one hour and 40 minutes, this giving the temperature drop at the intervals shown in Table IV for oven M, Table V for oven O, and Table VI for oven L. In the

last column of each table is given the average drop of the six thermocouples. In Figure 2 the average drop in  $^{\circ}\text{C}$ . is presented graphically, the curves bearing the letters representing the respective ovens. We thus observe the influence on oven temperature of opening the door.

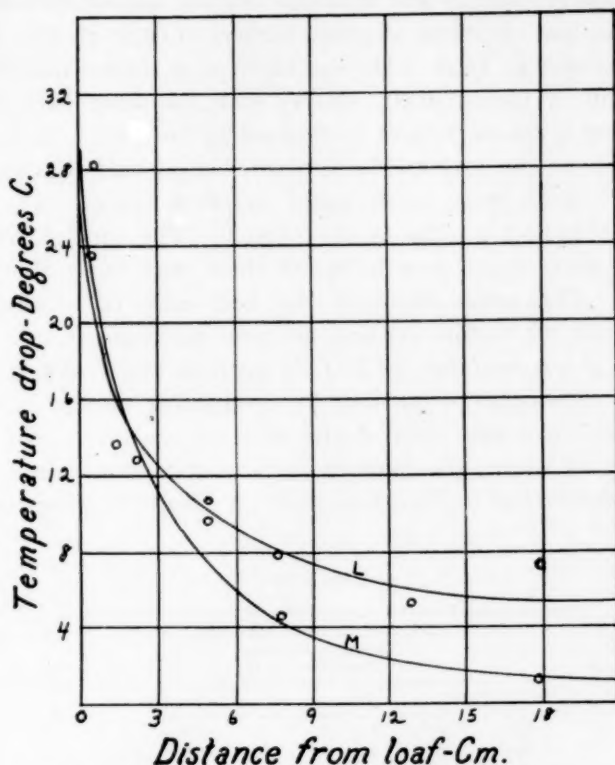


Fig. 3. Temperature Drop at Different Distances from Pans

The temperature change when the thermocouples were placed at different distances from the loaves was next investigated. First, a natural-draft oven was used and the shelf was not rotated. Thermocouples were placed at the distances shown in Table VII. The oven had a capacity of six loaves while these tests were being conducted. The temperature drop was obtained as before, namely, by subtracting the respective thermocouple readings after the load was placed in the oven from their readings when the oven was empty. The readings were taken as rapidly as possible, so the time limit involved was not more than 5 minutes. In Figure 3, Curve A, we have the average readings plotted against the distances in cm. Inspecting this curve, we at once realize the necessity of a definite statement as to the exact location of

the temperature recording instrument in respect to the distance from the loaf. This temperature drop is due to the vapors of water, alcohol, etc., coming from the dough mass. The nearest a thermocouple was placed to a loaf was approximately 0.5 cm. At this and lesser distances, the curve changes rapidly and indicates that the temperature drop very close to the loaf is many degrees higher. Curve B, the data for which are shown in Table VII, was taken in a similar manner but in an oven with a forced draft. Here, with the same load, the temperature drop is not so great at corresponding distances. It means that the vapors from the loaf are being carried away and the heat supply replenished. Both these ovens baked excellent loaves. The type of loaf obtained in both was the same—Type F. The crust obtained from the forced-draft oven was browner than that from the natural-draft oven. This amply illustrates that heat intensity, or temperature, is only one of the factors relating to oven specifications. In natural-draft ovens at a temperature of 230°C., a certain crust color is obtained, whereas if convection is assisted by mechanical means, by either a rotating shelf or a fan, other shades of color are given. In the final specification of ovens, the number of heat units transferred per unit of time to the loaf at a given heat intensity should be given some consideration.

TABLE IV  
TEMPERATURE DROP OF OVEN M DUE TO OPENING OF DOOR<sup>5</sup>

Time door was open min.	Temperature drop of thermocouples, °C.						Average temperature drop °C.
	1	2	3	4	5	6	
0	2.0	5.0	4.0	0.2	0.4	1.6	2.2
5	1.0	5.2	4.6	1.0	0.6	1.8	2.4
10	1.6	5.6	3.2	1.6	.....	2.2	2.8
15	1.8	6.6	4.0	.....	0.8	2.0	2.5
20	1.8	6.6	2.2	1.6	0.4	2.2	2.5
25	2.8	6.0	3.4	2.4	2.0	3.4	3.3
30	0.8	4.6	4.0	1.6	2.0	3.4	2.7

TABLE V  
TEMPERATURE DROP OF OVEN O DUE TO OPENING OF DOOR

Time door was open, min.	Temperature drop of thermocouples, °C.						Average temperature drop °C.
	1	2	3	4	5	6	
0	16.4	26.4	25.0	28.0	22.0	23.2	23.5
5	27.0	27.4	26.6	31.8	24.0	23.8	26.8
10	26.8	28.8	28.4	33.6	26.0	25.8	28.2
15	29.0	29.2	29.8	37.2	29.2	27.2	30.3
20	30.2	30.0	31.6	37.6	29.0	28.8	31.2
25	30.4	32.6	33.6	40.8	31.2	29.0	32.9
30	32.2	33.0	34.2	41.2	33.0	32.8	34.4

TABLE VI  
TEMPERATURE DROP OF OVEN L DUE TO OPENING OF DOOR

Time door was open, min.	Temperature drop of thermocouples, °C.						Average temperature drop °C.
	1	2	3	4	5	6	
0	26.8	35.6	44.0	40.0	25.8	35.4	34.6
5	38.0	38.4	55.2	44.0	29.2	42.8	41.3
10	35.2	41.4	52.2	48.0	32.0	39.9	41.3
15	40.4	40.4	51.8	44.4	28.4	40.2	41.0
20	43.0	40.4	57.8	46.8	29.4	42.6	43.0
25	34.0	42.0	54.4	45.0	28.8	40.8	40.8
30	40.6	43.2	55.2	48.6	29.4	41.6	43.1

Each of the ovens was allowed to heat for two hours, at the end of which time the temperature control apparatus was adjusted so that the average temperature of each oven was 230°C. Two loaves were now introduced, the doors and vents of the oven were closed, and temperature readings were taken at the time intervals shown in Table VIII for oven M, Table IX for oven O, and Table X for oven L. Here, as before, the temperature drop is obtained by subtraction of the temperature at the times stated in the tables from the temperatures of the oven before loading, as indicated by each thermocouple. In the last column is found the average temperature drop of the oven. Similarly in Tables VIII, IX, and X will be found the temperature changes of the respective ovens for the various time intervals when the load was increased to four, six, and eight loaves where the last was possible. The graphical presentation of the data is found in Figure 4 for oven M, Figure 5, for oven O, and Figure 6 for oven L. The curves for ovens O and L are not so smooth as for oven M, because both O and L are natural-draft ovens. The velocity of the heat was not constant. The thermostat would throw the power on. This would very quickly change the velocity of the air currents, velocity as here used implying change of direction as well as speed per unit time. When the thermostat would disconnect the power, the velocity would again change. This made it exceedingly difficult to obtain smooth curves with a natural-draft oven. Heat currents have definite velocity only when there is a constant difference in heat potential, or temperature, or when the velocity is maintained constant by mechanical means. We would expect, if there were a large difference in temperature in a natural-draft oven, that a more nearly constant velocity would be maintained. This was definitely proved when the doors of ovens O and L were opened and a temperature difference sufficiently great was established.

TABLE VII  
TEMPERATURE DROP AT DIFFERENT DISTANCES FROM PAN

Distance of thermocouple from pan, cm.	Temperature drop of thermocouple, °C.					
	0.509	2.54	5.09	7.6	12.7	17.8
Natural-Draft Oven						
	17.6	9.6	5.8	4.6	-0.6	2.8
	18.0	14.0	14.2	11.4	9.8	11.4
	26.0	13.4	3.0	5.6	2.2	4.6
	26.0	13.8	15.2	9.6	8.6	10.6
	29.2	12.2	5.6	4.8	0.8	2.6
	24.8	14.4	14.8	11.4	9.8	10.6
Average	23.6	12.9	9.8	7.9	5.1	7.1
Forced-Draft Oven						
	0.509	1.7	5.09	7.6	17.8	
	31.6	18.4	12.8	4.2	4.0	
	24.6	15.0	11.6	5.0	3.6	
	34.4	15.0	10.8	4.8	-6.8	
	30.8	12.2	11.8	4.6	2.6	
	25.6	12.4	10.4	4.4	2.0	
	22.4	10.0	8.4	3.6	2.2	
Average	28.2	13.8	10.9	4.4	1.2	

TABLE VIII  
TEMPERATURE DROP WITH DIFFERENT LOAD CAPACITIES FOR OVEN M

Load capacity, No. of loaves	Time interval, min.	Temperature drop of thermocouples, °C.						Average temperature drop, °C.	Maximum temperature drop, °C.
		1	2	3	4	5	6		
2	0	1.4	0.6	3.4	4.4	3.0	0.4	2.2	4.0
	5	0.0	-0.4	2.2	3.0	2.8	0.2	1.3	3.4
	10	-0.6	0.4	2.6	2.4	2.4	1.6	1.4	3.2
	15	0.0	0.0	2.4	1.8	1.6	0.8	1.1	2.4
	20	-0.6	-0.2	2.4	1.4	1.4	0.4	0.8	3.0
	23	0.0	0.0	2.0	1.2	0.2	0.8	0.7	2.0
4	0	11.2	8.6	15.2	10.8	13.8	0.4	10.0	14.8
	5	0.8	-1.2	7.2	6.0	8.0	1.8	3.8	9.2
	10	0.8	-1.6	5.6	5.4	6.8	2.0	3.2	8.4
	15	0.6	-1.8	5.6	4.2	5.6	1.4	2.6	7.4
	20	0.8	-1.4	4.6	3.8	4.8	0.8	2.2	6.2
	23	1.0	-0.8	4.0	3.4	4.6	1.0	2.2	5.4
6	0	14.4	8.6	13.8	12.2	16.2	6.0	11.8	10.2
	5	2.0	1.4	4.4	6.8	10.2	4.0	4.8	8.8
	10	2.8	-0.2	3.0	5.8	8.6	3.0	3.8	8.8
	15	2.0	-1.0	4.0	4.6	7.4	1.6	3.1	8.4
	20	0.6	-2.2	4.4	4.0	2.8	1.8	1.9	6.6
	23	0.2	-2.4	2.6	3.8	4.0	1.2	1.5	6.4
8	0	28.4	24.0	26.6	26.0	28.4	20.2	25.6	8.2
	5	10.4	4.4	7.0	6.6	13.0	8.2	8.2	8.6
	10	6.6	3.8	7.6	8.6	11.2	6.6	7.4	7.4
	15	5.2	3.2	5.6	7.2	9.6	6.0	6.1	6.4
	20	4.2	0.6	4.6	6.2	7.6	3.6	4.4	7.0
	23	2.0	1.4	3.8	6.2	7.4	4.0	4.1	6.0

TABLE IX  
TEMPERATURE DROP WITH DIFFERENT LOAD CAPACITIES FOR OVEN O

Load capacity No. of loaves	Time interval, min.	Temperature drop of thermocouples, °C.						Average temperature drop, °C.	Maximum temperature drop, °C.
		1	2	3	4	5	6		
2	0	3.4	6.2	3.0	-1.8	1.0	0.0	1.9	8.0
	5	2.4	1.4	0.0	-2.2	2.4	1.6	0.9	4.6
	10	4.2	3.6	1.8	0.4	3.8	4.0	2.9	3.8
	15	-0.8	3.6	3.2	4.2	2.0	3.4	2.6	5.0
	20	-2.8	1.6	2.4	2.8	2.0	3.2	1.5	6.0
	23	2.4	5.4	3.6	1.2	-2.0	4.0	2.4	7.4
4	0	22.0	19.2	15.2	10.0	9.2	4.0	13.3	18.0
	5	7.0	14.4	11.4	10.8	11.0	8.6	10.6	7.4
	10	5.6	12.8	9.8	9.6	8.4	6.4	8.8	7.2
	15	7.4	1.0	6.2	5.2	6.4	5.2	5.3	6.4
	20	13.8	12.0	16.0	1.2	4.2	2.4	8.3	12.6
	23	9.6	13.0	9.6	9.0	7.2	5.6	9.0	7.4
6	0	27.2	22.8	20.2	12.6	13.0	12.2	18.0	15.0
	5	10.8	10.2	8.8	2.8	4.6	5.8	7.2	8.0
	10	16.6	17.2	11.4	1.6	10.0	6.8	12.3	15.6
	15	10.4	13.6	10.6	4.8	6.6	9.8	9.3	8.8
	20	9.6	9.4	9.0	1.0	6.4	7.2	7.1	8.6
	23	12.2	15.8	12.5	18.0	-0.4	-1.4	9.6	17.2

TABLE X  
TEMPERATURE DROP WITH DIFFERENT LOAD CAPACITIES FOR OVEN L

Load capacity No. of loaves	Time interval, min.	Temperature drop of thermocouples, °C.						Average temperature drop, °C.	Maximum temperature drop, °C.
		1	2	3	4	5	6		
2	0	3.2	1.8	3.2	5.2	-2.6	-0.7	1.7	7.8
	5	-0.8	0.8	6.8	3.0	5.0	5.0	3.3	7.6
	10	1.2	1.0	5.4	4.2	4.0	4.0	3.3	4.4
	15	3.0	0.8	3.6	-0.6	0.8	2.2	1.6	4.2
	20	-0.2	4.4	8.4	5.6	0.8	-1.2	2.9	9.6
	23	2.2	5.2	10.0	2.8	0.4	-1.2	3.2	11.2
4	0	7.0	7.6	9.4	1.8	4.8	3.4	5.7	7.6
	5	-2.2	3.4	8.8	2.4	5.8	6.8	4.2	11.0
	10	5.0	7.8	12.6	1.4	3.0	4.6	5.7	11.2
	15	4.6	4.0	8.0	4.6	4.8	6.2	5.3	4.0
	20	-1.2	4.0	10.0	7.6	6.4	3.0	5.0	11.2
	23	-0.2	2.6	10.4	8.0	5.2	0.8	4.5	10.2
6	0	12.2	10.2	14.4	9.6	9.0	6.2	10.3	8.2
	5	-2.2	-2.2	6.4	3.8	5.4	6.2	2.9	8.6
	10	6.4	6.6	7.6	4.8	6.4	7.0	6.5	2.8
	15	-1.0	4.2	10.8	8.6	7.2	7.2	6.2	11.8
	20	3.2	2.0	6.0	7.4	6.0	6.0	5.1	5.4
	23	5.2	2.0	9.6	2.2	2.4	3.2	4.1	7.6
8	0	17.8	15.2	18.4	16.2	16.8	12.0	16.1	6.4
	5	0.6	1.6	7.0	3.0	5.2	0.0	2.9	7.0
	10	0.6	-1.2	6.8	5.8	6.4	7.2	4.3	8.4
	15	4.0	0.4	9.6	11.0	8.4	7.2	6.8	10.6
	20	3.8	0.2	8.6	9.6	8.4	8.6	6.5	9.8
	23	3.0	-1.4	8.6	8.8	7.0	9.2	5.8	10.6



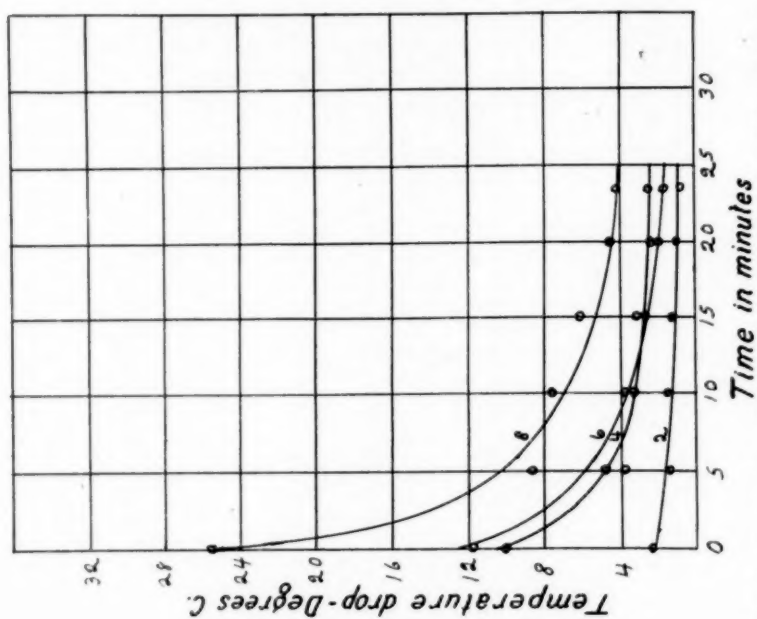


Fig. 4. Temperature Drop Curves for Ovens with Different Loads

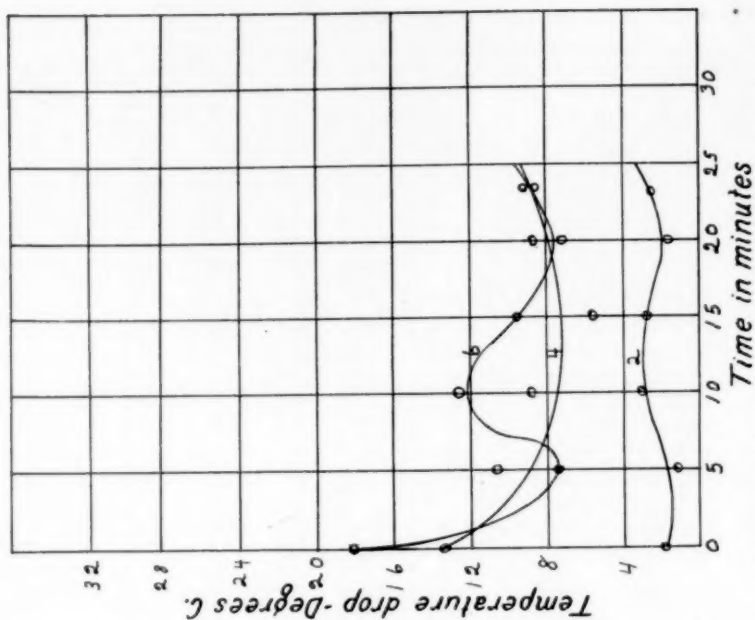


Fig. 5. Temperature Drop Curves for Oven 0 with Different Loads

Referring again to curves O and L in Figure 2, we note that they are very smooth as compared with the curves in Figures 5 and 6. The points of all these curves consisted of the same number of average readings. The opening of the doors (Fig. 2) made it easy to secure smooth curves. This was very difficult (Figs. 5 and 6) when the door was closed, altho the shelf was rotating.

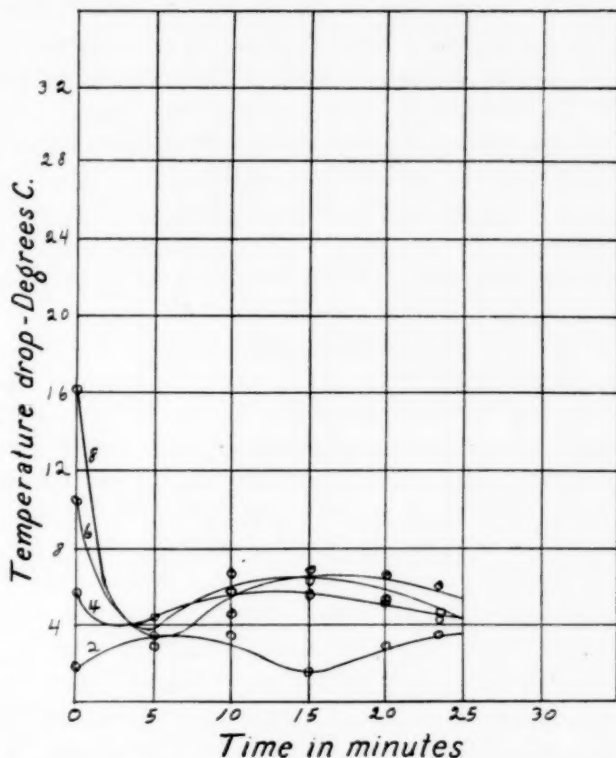


Fig. 6. Temperature Drop Curves for Oven L with Different Loads

All three ovens baked well. As has previously been stated, there were some differences in crust color. The type of loaves obtained by the ovens was similar. All three have excellent baking qualities.

### Summary

1. The distance the temperature recording instrument is placed from the pan should be definitely stated, as the temperature drop recorded is dependent thereon.

2. Temperature changes at a given distance within the area influenced by the vapors from the dough are not the same for a natural draft and a forced-draft oven.

3. The number of heat units transferred to the dough surface per unit time depends upon the temperature of the transferring medium and the degree to which convection is hastened by employing rotating shelves, fans, etc

4. When the temperature of the transfer medium is  $230^{\circ}\text{C}$ . (plus or minus 2) at a distance of 5.09 cm. from the pan, the shade of crust color varies somewhat. Where the heat transfer is rapid, as with forced drafts, crusts are browner.

5. When the convection currents were somewhat constant in respect to velocity, smooth curves were obtained.

6. Excellent baking results were obtained in all ovens, the type of loaf being the same.

7. None of the ovens tested fulfill the requirements of the Standard Experimental Baking Test, even tho the load capacity is reduced to two loaves. Ovens M and L almost fulfill the conditions of the specifications with this minimum load.

8. Ovens can be built that will fulfill the specifications, but the cost of production is probably prohibitive to many laboratories. Oven M came within  $0.2^{\circ}\text{C}$ . of fulfilling the specifications with a load capacity of two loaves. To construct an oven that will fulfill the specifications with load capacities considerably larger will cost more.

9. The specifications have not given definite consideration to the quantity of heat transferred per unit of time. The specifications have been so exacting in regard to temperature variation, namely, plus or minus  $2^{\circ}\text{C}$ ., that it is almost impossible to obtain ovens that will meet the requirements. This is especially true where a large number of loaves are to be baked daily. These specifications make it impossible for many association members to use the Standard Experimental Baking Test. It is therefore suggested that the specifications pertaining to ovens be revised.

10. It is understood that the results described in this paper apply only to the specific type of ovens tested. As a result of these tests some refinements have been made in some of the ovens tested.

### Tests of Dough Thermometers

R. C. SHERWOOD

Minnesota State Testing Mill, Minneapolis, Minn.

The baking test committee in session in Chicago March, 1929, approved the adoption of a special short thermometer to be known as A.A.C.C. dough-testing thermometer, to be graduated from 15° to 40°C. (60°-100°F., optional).

Ten thermometers submitted to the chairman of the committee were tested for accuracy at five different points, 10° intervals between 60° and 100°F., and for sensitivity as measured by time to rise from 66° to 86°F. A Bureau of Standards thermometer graduated in Centigrade was used as the standard for the tests for accuracy. In addition, measurements were taken of the thermometers in an effort to determine what specifications were desirable for the standard dough thermometer. All thermometers tested were graduated in Fahrenheit.

Nearly all the thermometers had broken columns when received, some of which were reunited only with difficulty. In one case it was necessary to resort to centrifuging at high speed for several minutes to reunite the column.

Only one thermometer was found to be accurate within  $\pm .1^\circ\text{F.}$  at all points tested. Three more were found accurate within  $\pm 0.3^\circ\text{F.}$  Eight of the ten thermometers were found to be accurate within an error of  $\pm 0.3^\circ\text{F.}$  in the range more frequently used for dough testing, namely 70°-90°F.

Experimental error in reading some of the thermometers was appreciable, possibly  $0.2^\circ\text{F.}$ , because of the short distance between divisions of the scale.

Sensitivity, as measured by time in seconds required to rise from 66° to 86°F. varied from 12 to 50 seconds. Three thermometers showed a rise of 20° in 20 seconds or less, 2 more in 30 seconds or less, 2 more in less than 40 seconds. Sensitivity appeared to be determined by the shape and size of the bulb. The bulbs that tapered to a point appeared to be made of thicker glass, which probably lowered the sensitivity. With one exception the rounded bulbs were the more sensitive. Four thermometers had an immersion mark; seven were graduated in 1° intervals, 2 in 2°, 1 in 0.5°. While the thermometers were similar in length, varying from 13 to 17 cm., the range covered by the scale showed considerable variation, from a maximum of 0° to 130°F. to a minimum of 60° to 100°F. The distance between the 60° and 100° marks, which were specified by the baking test committee, varied from

24 to 101 mm. Those graduated from 60° to 100°F. varied from 56 to 101 mm. Judging from the shape and size of the bulbs, the smaller bulbs showed greater sensitivity.

Magnifying scales were used on three of the thermometers. Such scales can be read more accurately, but have the slight disadvantage of being seen only in one position. One thermometer had a red background against which the magnified column of mercury was sharply contrasted and very easily read.

### Recommendations

Accuracy should be within  $\pm 0.2^{\circ}\text{C}$ . ( $\pm 0.36^{\circ}\text{F}$ .) at all points on the scale. Correction factors could be applied if there were inaccuracies, but this should be avoided. Sensitivity should be great enough to show a rise of 20° in 30 seconds or less. Mercury should be the fluid used.

The following specifications are suggested:

Total length, 16 to 17 cm.

Diameter of tube, 8 mm.

Length of bulb, 20 mm.

Maximum diameter of bulb, 5 mm.

Immersion mark, 40 mm. from the tip.

Scale should be 15°-40°C. (60°-100°F.) beginning about 15 mm. above the immersion mark. The distance between 15° and 40°C. should be 100 mm., scale graduated in intervals of 0.5°C. A plain scale without magnification is recommended.

It is further recommended that these tentative specifications be submitted to the manufacturers for their counsel before official adoption.

TESTS OF DOUGH THERMOMETERS SUBMITTED TO BAKING TEST COMMITTEE

Thermometer No.	Variation from standard thermometer at different temperatures					Sensitivity Time to rise from 66°F.-86°F., sec.
	60°	70°	80°	90°	100°	
1	0.7	0.6	0.3	0.1	0.1	30
2	0.1	0.0	0.2	-0.3	-0.1	13
3	broken Hg column					
4	0.0	0.0	0.1	0.0	0.0	40
5	0.0	0.0	0.1	-0.1	-0.7	45
6	0.1	0.2	0.0	-0.1	-0.1	20
7	0.2	0.0	0.1	0.0	-0.5	50
8	-0.4	-0.3	-0.1	-0.2	-0.5	25
9	-0.4	-0.3	-0.1	-0.2	-0.3	17
10	0.0	0.0	0.1	-0.2	-0.3	35

Thermometer No.	Entire length	Diameter of tube	Range	Distance Between 60° and 100° marks	Length of bulb	Diameter of bulb
	mm.	mm.	°F.	mm.	mm.	mm.
1	153	8	0-120	27	29	7
2	142	8	-30-120	24	14	5
3	169	7	60-100	90	23	6
4	154	7	30-100	50	23	6
5	168	7	60-100	101	19	6
6	133	7	0-130	25	19	4
7	153	8	40-100	62	15	8
8	131	6	60-100	56	17	6
9	146	8	60-100	69	21	5
10	157	8	60-100	60	25	7

Thermometer No.	Shape of tip	Immersion mark from tip	Type of scale	°F. per division
		mm.		
1	pointed	..	plain	1
2	round	..	"	2
3	semi-pointed	38	mag.	1
4	pointed	..	"	1
5	semi-pointed	37	"	1
6	round	..	plain	2
7	round	..	"	1
8	round	38	"	½
9	round	..	"	1
10	pointed	51	"	1

### Covered Fermentation Bowls

A. A. TOWNER

Red Star Milling Company, Wichita, Kansas

At a meeting of the Baking Committee in Chicago, on March 20, after a partial report of my proofing cabinet work, I was requested by the chairman, Mr. Harrel, to secure some temperature data under forced circulation of air; also to investigate the matter of covered fermentation bowls. Excuses are never in order for members of Mr. Harrel's committee, therefore it suffices to say that I chose not to undertake the first problem but devoted my time to the latter.

Seven 4-dough tests were made in which 2 doughs, one open and the other closed, were fermented on the bottom shelf and 2 on the top shelf. The rheostat was set at high and the control set to maintain a temperature of 83°F. by the index thermometer, which was located on the right back wall of the cabinet. The mean temperature of the doughs, open and closed, and the air at those points were as follows:

	Air °F.	Range °F.	Open dough °F.	Closed dough °F.
(4 tests)				
Bottom shelf	87	85-88	85	88
Top shelf	87	86-87	85—	87—
(3 tests)				
Bottom shelf	88.5	87-90	86	88+
Top shelf	85.0	84-87	85.5	87

The relative humidity in the cabinet was 84°F. In the closed bowls the humidity remained 96° and above.

Several tests were conducted under the above conditions and data obtained on the effect of the closed fermentation bowls on the physical properties of the dough, noting any change in the resultant loaf weight and loaf volume. It was observed that with the closed bowl there is a tendency for the dough to rise rapidly to the high point of the air temperature range and to remain more or less constant at that point.

The result of these tests, coupled with previous experience leads me to the belief that for the tentative Standard Experimental Baking Test the problem of humidity is best solved by the use of the covered fermentation bowl and pan caps. If this system were incorporated in the specifications of the standard test, it would at once eliminate one of the most expensive as well as one of the most difficult features of proofing cabinet construction.

### Baking Pans

L. D. WHITING

Ballard and Ballard, Inc., Louisville, Ky.

In the Standard Experimental Baking Test, described in Cereal Chemistry, vol. 5, March, 1928, the only specifications given regarding baking pans, in addition to the dimensions, are that they should be "preferably of rust-proof material requiring little or no greasing."

At present the pans in use in various laboratories are not uniform in material or even in dimensions. Further work on pans and more rigid specifications for this equipment were therefore undertaken. Private correspondence with several chemists developed the fact that the weight of metal used in the pans is thought to influence baking results greatly. Also the fact developed that some chemists grease pans and some do not. Therefore the greasing of pans was investigated.

### Greasing of Pans

To determine the effect on loaf volume of greasing the pans, an equal number of loaves was baked in greased pans and in ungreased pans and the volume of the loaves was recorded as follows:



Flour	Volume in ungreased pans cc.	Volume in greased pans cc.	Decrease in Volume %
B	564	453	19.9
"	564	499	11.5
"	564	546	3.2
"	564	546	3.2
"	564	546	3.2
"	564	518	8.1
"	610	564	7.5
"	564	555	1.6
AA	481	425	11.6
B	555	471	15.1
W	582	496	14.7

The pans were greased by brushing them lightly and as uniformly as possible with a greased cloth, but no attempt was made to weigh the amount of grease used.

The loaves baked in greased pans were all smaller than those baked in ungreased pans. The percentage of decrease in volume varied from 1.6 to 19.9. It is apparent that varying amounts of grease used will cause loaf volume to vary.

Similar observations were made by C. G. Harrel.

#### Materials for Pans

To collect data on the different materials, pans of the proper dimensions made from various weights and kinds of metal, which were thought suitable, were obtained from a pan manufacturer, and a series of baking tests was made. A description of the pans is as follows:

Iron pan—28-gauge black iron, 0.40 mm. thick

2XX tin pan—27-gauge, 155 lb. stock, 0.43 mm. thick

4XXXX tin pan—25-gauge, 195 lb. stock, 0.55 mm. thick

4XXXX tin pan, spotless metal—25-gauge, 0.55 mm. thick

Aluminum pan—20-gauge, 1.04 mm. thick

The pans were not greased in this series of bakes. The flour used was identical in all pans on the same day, but it was not identical from day to day, altho it was of the same type throughout the series. The following record of loaf volumes covers approximately 150 loaves baked on 16 different days. It may be seen that single loaves, duplicates, and triplicates, were baked in the various metals.

The loaf volumes shown in the table are averaged each day. Beneath the loaf volume for each kind of pan is recorded, in plus or minus percentage, its variation from the average daily volume.

Date	Flour	4X	2X 0.43 mm. thick	4X Spot- less	Iron	Alum- inum	2X 0.41 mm. thick	Av.	Av. daily volume
		cc.	cc.	cc.	cc.	cc.	cc.		cc.
2/5	B	564	527	555	537	.....	564	.....	549
		+2.7	-4.0	+1.0	-2.2	.....	+2.7	.....	
2/6	B	527	518	490	.....	.....	518	.....	513
		+2.7	+1.0	-4.4	Broken	.....	+1.0	.....	
2/8	B	536	490	527	481	.....	499	.....	506
		+5.9	-3.1	+4.0	-4.9	.....	-1.3	.....	
2/14	B	573	629	564	555	.....	610	587	582
		-1.5	+8.0	-3.0	-4.6	.....	564	+8	
2/20	B	527	573	545	601	.....	564	.....	
		-4.7	+3.6	-1.0	+8.6	.....	536	542	553
							527	-2.0	
2/26	B	582	601	555	Broken	573	601	.....	
		-0.8	+2.3	-5.4	.....	564	610	603	587
						-3.2	610	+2.7	
							592	.....	
2/27	B	619	610	572	Broken	536	592	.....	
		+7.6	+6.0	Even	.....	536	555	576	575
						-6.8	582	Even	
3/11	B	508	518	536	.....	499	555	.....	
phos.		-3.0	-1.1	+2.3	.....	-4.8	518	536	524
							536	+2.0	
3/13	B	527	518	518		518	545	.....	
phos.		-0.5	-2.2	-2.2		527	518	542	530
						-1.5	564	+1.5	
3/14	B	508	545	545		536	545	.....	
		-7.5	-0.7	-0.7		-2.9	564	s551	
							545	even	549
							555	.....	
							555	c566	
							590	+3.1	
3/15	B	564	582	575		536	592	.....	
		-0.7	+2.4	+1.2		-5.0	582	s576	
							555	+1.2	
							545	.....	568
							582	c563	
							564	-0.8	
3/18	B	527	545	564		536	545	.....	
		-2.1	+0.9	+4.4		-0.7	545	s542	
							536	even	540
							536	.....	
							536	c533	
							527	-1.3	
3/19	B	518	508	499		499	518	.....	
C		-0.4	-2.0	-4.0		-4.0	536	c530	
							536	+1.8	520
							536	.....	
							545	s526	
							499	+1.0	
3/20	B	545	555	564		527	527	.....	
		+2.2	+4.1	+5.6		-1.0	555	s530	
							508	-0.5	533
							508	.....	
							527	c518	
							518	-4.9	
3/21	B	527	545	545		545	535	.....	540
		-2.4	+0.9	+0.9		+0.9	-0.7	.....	

Tests in iron pans discontinued

Date	Flour	4X	2X 0.43 mm. thick	4X Spot- less	Iron	Alum- inum	2X 0.41 mm. thick	Av.	Av. daily volume
3/22	B	527 -2.8	536 -1.0	545 +0.5	Tests in iron pans discontinued	545 +0.5	527 536 518 555 575 555	s527 -2.7 c562 +3.7	542
4/4	B		573 573 555 +1.0	564 +0.4		564 545 -1.4			562
4/5	B		573 610 601 +3.3	582 +1.0		564 527 -5.3			576
4/18	B		518 518 527 +0.6	500 490 -4.3		527 545 +3.3			518
4/22	B		545 527 555 even	536 545 536 -0.5		564 527 +0.5			542

An inspection of these figures reveals a slight tendency for the volumes from the aluminum pans to run below the daily averages. The volumes from the other metals sometimes run above and sometimes below the daily averages. There is no consistent tendency in either direction. The volumes from the 4X spotless metal show smaller variations from the average than the 4X or 2X tin. Characteristics of the loaf such as crust color, break, shred, and general appearance were the same, or nearly so, for all pans.

The loaves in the black iron pans were inclined to stick so badly that they were often broken in removing them from the pan. The iron pans rusted easily and caused trouble from spotting.

As aluminum pans will not stand hard usage, it was necessary to make them from relatively thick material—approximately 20 gauge. As aluminum is a porous metal it easily accumulates dirt and will not clean as readily as tin or spotless tin pans. Aluminum has the advantage over iron of not requiring greasing (altho chemists using aluminum pans are accustomed to grease them lightly at intervals).

The 2XX and 4XXXX tin pans and the 4XXXX tin spotless metal were satisfactory in regard to removing the loaves. In this respect these pans are nearly similar to aluminum pans. Spotless metal has the advantage of being easily cleaned and is more nearly stain-proof than the plain tin pans. If the dough is very sticky the loaves sometimes stick slightly.

### Pan Measurements

Eighteen pans made of the 4XXXX spotless metal, and submitted by a manufacturer, were carefully measured, with results as tabulated:

It will be seen by an inspection of these figures that if we allow a tolerance of 1%, four pans pass as all right, and if we allow a tolerance of 2%, sixteen of the pans pass as all right.

	Height at ends	Length at top	Width at top	Length at bottom	Width at bottom
	mm.	mm.	mm.	mm.	mm.
	68	105	60	93	53
1	68	106	59	91	53
2	68	106	59	92	53
3	67	107	59	92	52
4	68	107	59	91	53
5	68	105	58	90	53
6	67	107	59	92	53
7	68	105	60	91	53
8	68	106	58	93	53
9	68	107	60	92	53
10	68	106	58	90	53
11	68	107	60	91	51
12	67	108	59	93	53
13	67	107	59	93	53
14	68	106	59	92	53
15	67	106	59	93	53
16	68	106	59	93	53
17	67	107	59	93	53
18	67	106	59	93	51

### Conclusions

1. As considerable variation is introduced by greasing pans, for this reason a metal should be used that requires no greasing.
2. Pans made of 4XXXX tin spotless metal, 25 gauge, combine the qualities of durability and cleanliness; they are nearly stain-proof; they require no greasing, yet produce loaves that deviate less from the average than the 2X and 4X tin pans.
3. Eighteen pans made of 4XXXX spotless metal submitted by a manufacturer deviated slightly from the exact dimensions.

### Calibration of Loaf Measuring Apparatus

W. L. HEALD

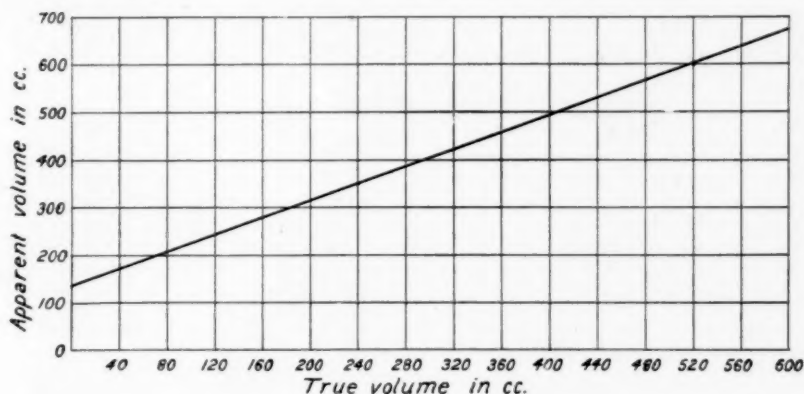
Larabee Flour Mills Co., Kansas City, Mo.

At the meeting in Chicago it was decided to do some work on the standardization of loaf volume boxes.<sup>1</sup> The method given was followed in this work. We checked our loaf measuring device and our findings are reported in the following table:

<sup>1</sup> Cereal Chem. vol. 5, pp. 220-222.

	1	2	3	4	Box
Weight of rubber, gr.	3.1	2.4	4.9	4.8	
Weight of balloon filled, gr.	99.6	238.4	417.0	596.3	
Weight of water, gr.	96.5	236.0	412.1	591.6	1279
Density of water	1.0032	1.0032	1.0032	1.0032	1.0032
Density of rubber	0.8597	0.8597	0.8597	0.8597	
Volume of rubber, cc.	3.61	2.8	5.7	5.6	
Volume of water, cc.	96.2	235.3	410.9	589.8	1275
Total volume, cc.	99.8	238.1	416.6	605.4	
Apparent volume from loaf meas. device, cc.	220	355	515	675	1145
Difference, cc.	120.2	116.9	98.4	96.6	130
Error %	54.6	32.9	19.1	10.3	11.35

Much to our surprise we found that our volume box reading was off 130 cc.



Four balloons were filled with water and total volume was found as recorded in the table. The four balloons were then placed in the loaf measuring box and their volumes determined and reported as apparent volume from loaf measuring device; using the true volumes as the abscissa and the apparent volumes as the ordinate, a curve was drawn through all points (Fig. 1).

Using this graph, we standardized our device in the following manner: To the apparent volume we added 130 cc. The true volume can then be read directly from the graph. In standardizing the apparatus it must be remembered that a correction factor cannot be established and used for all points on the measuring cylinder because of the packing effect of the seed, which is proportional to the force the seeds have when they come to rest.

$$F = Ma, \text{ where } a = \frac{V_t - V_o}{t}$$

M = Mass

$V_o$  = Initial velocity

$V_t$  = Velocity after time, t

#### Summary

1. This method is scientific as well as practical.
2. It is more accurate than the use of wooden blocks.
3. The above data prove the necessity of careful standardization of each measuring cylinder used, where any degree of accuracy is desired.

### THE FELLOWSHIP FUND OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

C. G. HARREL

Bakeries Service Corp., Jamaica, N. Y.

(Received for publication July 1, 1929.)

For several years the members of the various baking committees have given generously of their time, services, and funds in the furtherance of the Standard Experimental Baking Test. The members of the committees of each respective year are to be congratulated upon the progress attained. L. A. Fitz and M. J. Blish, former chairmen, are to be commended for their capable direction of the committee work. Dr. Blish has clearly shown that where proper environmental conditions are maintained, the tentative Standard Experimental Baking Test has given promising results. The maintenance of proper environmental conditions presents many problems for further work, one of the major problems being the personal element. This must be eliminated or reduced to a minimum. The collaborative tests of the committee this year have proved, beyond doubt, that even with collaborators most familiar with the test, environmental conditions were not always properly controlled. These tests have been a great benefit, especially to those engaged in the work. Truly a great deal of progress has been made.

In this issue of Cereal Chemistry is given a statement of the activities of the baking committee. Committees of other years could have prepared statements that would compare very favorably with this one. A careful analysis of this statement reveals the immense amount of work done by the members of the committee. It is believed



that if a series of collaborative tests were now conducted, which were restricted to a few most familiar with the procedure, more encouraging results would be obtained. To extend the tests so that a majority of our members can obtain favorable or comparable results presents many details that must be worked out.

The association, at its annual meeting in Kansas City in May, upon the suggestion of the baking committee, unanimously voted to establish a Fellowship fund. This Fellowship fund is to be maintained by contributions. As many members of our association have displayed an intense interest in this work, it is only just that each member be given an opportunity to make a voluntary contribution. To this end form letters were mailed to all members not in attendance at the Kansas City convention. It is to be distinctly understood that any contribution you make is to be entirely voluntary and no contribution will be considered too small. This is an exceedingly worthy cause. The maintenance of a Fellowship fund by our association speaks well for our standards.

Letters describing this Fellowship fund will be mailed out to all commercial organizations in the near future. Another way in which you can be a contributing factor in this progressive movement is for you personally to interest your organization. Present to them the following facts:

- (a) That this Fellowship fund is for the purpose of establishing one or more fellowships at some university or universities for the distinct purpose of making further progress in the standardization of the baking test.
  - (b) That this problem is of interest to three great American industries, agriculture, milling, and baking.
  - (c) The place of establishing the fellowship or fellowships is to be decided by the baking committee. Such institutions as the University of Nebraska, University of Minnesota, Mellon Institute, Kansas State Agricultural College, are to be considered.
  - (d) That the baking committee, of which C. H. Bailey is chairman, is composed of one university professor, one agricultural experiment station chemist, one milling chemist, and two baking chemists. The fellowship will be under the supervision of the baking committee.
  - (e) The benefits your own organization will receive.
- The above list could be continued.



You are a major factor in interesting your organization in this project. Your association is depending on you for assistance in the interest of one of its greatest problems. If you desire further information, a letter addressed to the writer or to the chairman of the baking committee will be given immediate attention.

### REPORT OF COMMITTEE ON METHODS OF TESTING CAKE AND BISCUIT FLOURS

MARY M. BROOKE, Chairman

(Read at the Convention, May, 1929)

#### Committee and Association Recommendations, June, 1928

The Committee on Methods of Testing Cake and Biscuit Flours, at the Convention in Minneapolis in June, 1928, considered a report of the year and adopted the following recommendations for future work.

#### Recommendations of collaborators

1. That we determine and recommend such factors as are offered in the criticisms of the collaborators in making our first collaborative test.
2. That further collaborative cake baking tests be made. Other baking tests than cake were considered, but it was decided to continue along the same line. This will give us enough work for the time being.
3. That Method 1, as used in the first collaborative test, be used in all future work. Method 1 is as follows: Sift together all dry ingredients—flour, salt, powdered milk, egg albumen, and baking powder. Sugar and shortening are first creamed together for a definite length of time, about 12 minutes. This you can best determine for yourself as a matter of criticism to the method. Then water and dry ingredients are added alternately. After adding all the ingredients, the mass is beaten for 2 minutes.

4. That formula 1 be modified to read as follows:

	gm.	
Flour . . . . .	225	—amount to calculate on 15% moisture basis
Sugar . . . . .	175	
Hydrogenated shortening . . . . .	75	
Water . . . . .	250	
Powdered milk . . . . .	15	
Egg albumen . . . . .	5	
Salt . . . . .	3	
Cream of tartar . . . . .	6	
Soda . . . . .	3	

To be used as a basis of collaborative work.

5. That the next collaborative test be made with three flours, using first the standard formulas and then modifications—such modifications and directions to be chosen by the chairman.
6. That methods of procedure, size of pan, time of creaming, temperature of creaming, and all other necessary specifications be given by the chairman.

#### Instructions for First Collaborative Test of 1928-29 Period

Pursuant to the recommendations of the committee, samples were sent out in November for the second collaborative test. We delayed sending samples until this time because of press of seasonable work. Samples of flour were sent out by W. H. Stroud and egg albumen and powdered milk by A. A. Schaal.

Instructions were as follows:

That the formula and the method as incorporated in the recommendation of the committee should be used and that the following instructions should be followed.

Further details of procedure are as follows:

1. Hobart mixer, laboratory type, with small bowl (5 qt.) and creaming beater are recommended. The bowl, if possible, should be of Monel metal and the beater of bronze. Two speeds are used in this test—first speed 80 r.p.m., and second, 140 r.p.m., or as near these speeds as you may obtain. (Note: These mixers all vary in speed.)

2. In creaming sugar and shortening, the shortening should be creamed one minute at low speed, sugar added gradually at same speed, the entire operation being of 2 minutes duration. Speed should then be increased to second speed and mass creamed 10 minutes. As you change from one speed to the other, scrape down sides of bowl with a spatula.

3. Temperature of cream should be 70°F. as the maximum reached.

4. After creaming operation, water and dry ingredients are added alternately. This operation should not consume more than 30 to 45 seconds. Mass is then beaten 2 minutes. Dough should be 70°F.

5. Size of pan  $3 \times 6\frac{3}{4}$  inches bottom measurement,  $3\frac{1}{2} \times 7\frac{1}{2}$  inches top measurement and  $2\frac{1}{4}$  inches deep.

6. Scaling weight,  $10\frac{1}{2}$  oz. You will obtain two cakes from the formula, comfortably, without having to scrape the sides of the bowl.

7. Pan liners of thin manila paper should be used. Sample of satisfactory type was enclosed with instructions.

8. Temperature of baking 375°F. in an electric oven with fairly heavy tile hearth.

9. Time of baking, 20 to 25 minutes. This time should be as short as possible to get best volume, and, at the same time, thorough baking. Time will undoubtedly vary with ovens. The better insulated and heavier the hearth the shorter the time required, even though the temperature be the same.

10. Volume may be taken with a seed box. A loaf this size fits nicely into the volume apparatus of the standard bread baking method, with a box adapted to the shape of the cake.

#### Reports of First Collaborative Test of 1928-29 Period

Reports from the collaborators were received 100% and a meeting of the committee to consider these reports was held in the office of W. E. Long & Company on January 29, 1929. Messrs. Meyer, Alexander, Jackson, Stroud, and Mrs. Brooke were present.

The first matter of consideration was the study of the reports of the collaborative baking test, reports having been received from eleven of the twelve collaborators. We were pleased with results obtained; they seemed more concordant than we had anticipated.

Following are the relative positions of flours given by the different collaborators:

Collaborator	Flour			
	1	2	3	4
Meyer	3	2	1	4
Whiting	3	2	1	4
Jackson	2	3	1	4
Schaal	3	1	2	4
Brooke	3	1	2	4
Libby	1	2	3	4
Fisher	4	1	2	3
Glabau	3	1	2	4
Stroud	2	3	1	4
Morison	3	2	1	4
Bailey, L. H.	3	4	2	1
Alexander	2	3	1	4

It was then decided: (1) That the second collaborative test should be undertaken; (2) that the committee should undertake other problems and methods of testing; (3) that instead of the committee as a whole undertaking these problems, individual members of the committee should undertake different problems; (4) the "Study of Viscosity," with Mr. Meyer as sponsor; the "Study of a Cake Score Card," with Mr. Jackson as sponsor; and the "Study of Standard Cake Test Formula," with Mr. Alexander as sponsor, should be undertaken. In explanation of the last study, we decided that possibly after working out the details of manipulation, it would be best if we had or would consider a different formula.

#### **Recommendations of Committee Following First Test**

Next, the committee considered the second collaborative test and suggestions such as were thought necessary in methods and details for the second test. The following decisions were made:

1. To leave the formula as it is, since the sub-committee would work on a different formula as a specialized problem.
2. To increase the number of samples on the second test. Dr. Stroud would furnish these samples and would also determine the number of samples to be sent out. A preference of about ten samples was stated.
3. The size of the sugar crystals used in this test should be specified. Work has been done showing that there is a decided effect on the volume of cake with the size of the sugar crystals and whether or not they are natural or mechanically formed crystals. For this reason, it was thought best to specify the size of these sugar crystals.
4. Several of the collaborators had found that better results could be obtained by creaming the powdered milk with shortening. It was decided to try this method with the next collaborative test.
5. It was decided to allow some time and method for dissolving the egg albumen. In former work no provision was made for allowing the egg albumen to dissolve and the consequence is that the finished cake showed undissolved albumen. It was decided that the albumen should be allowed to stand in 100 cc. of water for 30 minutes, stirring occasionally. An alternative method was suggested of allowing the cake to stand 30 minutes after mixing. But it was decided that the temperature might affect the dough and was in this case considered an error.
6. Because we did not get as large volume with this type of

cake as with the ordinary commercial cake, it was decided that the scaling weight of the dough should be increased 12 ounces.

7. The consistency of the dough was too slack. It was decided to cut the water 20 cc.
8. It was important that the same type of pan liner be used by all collaborators and that in the second test a supply be sent out. Mrs. Brooke should send out the supply of pan liners.
9. A more careful study should be made of baking temperatures. This seems to be the main point of difference between the various collaborators. This is merely because different type ovens are used, some with continual heat, some with flash heat, and some with retained heat. It is hard for any one person to send specific directions for baking temperatures, and the time, under the present conditions, but it was decided that the collaborators be asked to make a careful study and a complete and detailed report on their baking time and temperature for this test.

#### **Instruction for Second Collaborative Test of 1928-29 Period**

Pursuant to the recommendations of the committee at this meeting, a second collaborative test was undertaken. There was a delay in sending samples, but samples were gotten out about April 1, with the following additional collaborative test.

1. Number of samples is increased to ten.
2. Granulated sugar of pan granulation, which will go through an 80-mesh sieve, shall be used. This type of sugar is commonly known as berry sugar.
3. The powdered milk should be creamed with the sugar and shortening.
4. Egg albumen shall be allowed to stand in 100 cc. of water for 30 minutes, stirring occasionally. In this way the albumen will be dissolved.
5. Scaling weight of dough shall be 12 ounces.
6. The water in the formula shall be cut 20 cc., making the formula read 230 cc. of water.
7. A complete report shall be made of baking time, temperature, type of oven, and insulation.

#### **Reports on Second Collaborative Test of 1928-29 Period**

The reports on the second collaborative test were studied by the committee on Monday, May 6, 1929. The results were not nearly so concordant, as was shown by the following table:



Collab- orator	Flour								
	1	2	3	4	5	6	7	8	9
1	4	2	9	8	7	6	5	1	3
2	4	5	8	7	3	1	2	6	9
3	2	8	7	9	6	3	5	4	1
4	8	3	9	5	2	1	6	7	4
5	3	4	7	9	8	2	5	6	1
6	1	4	5	9	8	6	7	3	2
7	8	9	7	1	2	3	4	6	5
8	9	7	6	8	1	2	5	3	4
9	8	7	9	4	3	2	1	5	6
10	6	1	2	9	3	5	7	8	4
11	5	2	1	8	9	6	7	4	3
12	3	5	8		6	4	7	1	2
Total points	61	57	78	77	58	41	61	54	44

The flours used were short patents, cut-offs, and cut straights, with different types and degrees of bleach. However, the collaborators reported that the cakes resulting from this test were so close in characteristics that it was difficult to distinguish among them.

A detailed study was made of the reports and factors on certain phases of the work were recorded. Following is a table of the volume obtained by different collaborators:

Volume, cc.

Collab- orator	Flour								
	1	2	3	4	5	6	7	8	9
1	No volume given								
2	830	810	810	820	840	830	870	800	?
3	602	575	582	557	614	570	610	601	581
4	730	738	720	720	755	730	742	725	725
5	647	647	652	632	635	662	680	695	690
6	849	821	782	744	752	832	820	830	759
7	No volume given								
8	660	640	620	660	700	640	620	600	500
9	No volume given								
10	730	762	716	693	656	707	721	740	693
11	585	590	543	512	585	557	573	588	562
12	805	767	759	...	744	799	784	791	762

It will be noticed that there is quite a difference in the volume obtained by different collaborators. This may be due to different volume taking apparatus or the volume obtained by different operators may vary.

A resumé of baking time and temperature and types of ovens was made as follows:



Collab- orator	Time, Min.	Temp. °F.	Oven
1	30-35	370	Despatch, tile hearth
2	50	375	Despatch, soapstone hearth
3	40	380	Despatch, tile hearth
4	37	375	Despatch, tile hearth
5	25-28	370	Westinghouse, tile hearth
6	28-33	375	Commonwealth Edison, tile hearth
7	40	375	Jewel Gas
8	25	420	Hotpoint Electric } household
9	33	400	Despatch, tile hearth
10	35	425	Fish, rotary soapstone hearth
11	45	375	Household Gas, Lorain
12	30	425	Despatch, transite hearth
			Despatch, tile hearth

### Committee Recommendations in Conclusion of Year's Work

The committee then made the following summary of the work:

1. As long as we tested flours of widely divergent characteristics we encountered no difficulties in getting concordant results. When we tested flours of closely related characteristics we found much less concordant results. We feel that this lack of concordance is due to failure in interpretation and scoring, and that a better method of interpretation, definition of characteristics, and scoring system is needed. This is by far the most important conclusion that can be drawn from this work.
2. A study of mixers and mixing methods from the mechanical standpoint is badly needed.
3. A study of ovens and oven temperature apparatus is necessary. Mr. Harrel is collaborating with this committee on this work and hopes to give us valuable data. It is recommended that any future committee undertake these details of study as stated. It is also recommended that the first specific problem be an arrangement whereby the committee meet in someone's laboratory equipped for such work and all work with the same ingredients and the same equipment to ascertain whether our differences are due to differences in equipment or to the personal equation.

### Conclusion

As a conclusion, let me give some observations made as chairman on the trend of future developments of this work. These are given for the consideration of the association in deciding the future fate of this committee and its work.

The work is now at about the same status as the standard bread baking test was three years ago. We will, however, be able to benefit

greatly by some of their work, probably in the study of ovens, thermometers, and other pieces of apparatus common to both types of testing, and most of all by their guidance.

However, cake baking will lend itself much more readily to a standard test, as it is much more mechanical. Also, it is a chemical combination which does not involve such a complicated study of unknown quantities in the form of yeast and enzymatic action.

Further, we have few prejudices to break down in this work as it is really pioneer with few prejudices formed.

However, the preliminary work has been done and we have now determined the detailed studies that will have to be made. This will involve the appointment of a large committee and the dividing of this committee into sub-committees for the study of various phases of the problem.

There must be a study of mixers, ovens, and thermometers, volume apparatus, scoring methods, and definitions of characteristics. Also, study should be made of other methods of testing soft flours than the baking tests.

This will all require a great amount of time and also an outlay of money far from small.

I am bringing these points before this association for their consideration and their pleasure, and to the knowledge of the president for his consideration in the appointment of future committee or committees.

#### Committee Work for 1929-30

President M. A. Gray appointed the following committee on Friday, May 10, 1929:

Mary Minton Brooke, Chairman	C. A. Armstrong
L. E. Jackson	L. H. Bailey
J. A. Dunn	C. H. McIntosh
George L. Alexander	E. E. Smith
V. E. Fisher	C. B. Kress

The committee met at noon of the same day and decided that each member should undertake a different phase of our problem, and that a report should be made later in the year on the work each had undertaken.

The following problems were assigned at this time:

- L. E. Jackson—Methods of Scoring.
- J. A. Dunn—Methods of Testing Flour to be Used for Other Purposes than Cake Baking.
- George L. Alexander—Mixing Time and Its Effect on Results of Standard Baking Test. This will be a study both of the Creaming Time and of the Mixing Time.

- V. E. Fisher—Effect of Temperature on the Dough and Its Influence on Standard Baking Test.  
C. B. Kress—Study of Water Tolerance of Soft Wheat Flours.  
C. A. Armstrong—Study of Various Types of Egg Albumen to be Used in Standard Baking Test.  
L. H. Bailey—Methods of Incorporating Ingredients and Their Effect on Standard Baking Test.  
C. B. McIntosh—Size and Shape for Pans and Their Effect on Standard Baking Test.  
E. E. Smith—Study of Viscosity as a Means of Testing Soft Wheat Flour.  
Mary Minton Brooke—A Study of the Correlation of the Standard Baking Test to Various Other Types of Cakes.

### MINUTES OF FIFTEENTH ANNUAL CONVENTION OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

M. D. Mize, Secretary-Treasurer

Hotel President, Kansas City, Mo.

May 6-10, 1929

Monday, May 6

Convention called to order at 10:15 a.m. by President C. E. Mangels  
Invocation by the Reverend I. M. Hargett, pastor, Grand Avenue Temple M. E. Church

Wm. C. Meyer, in the absence of H. E. Weaver, chairman of Local Arrangements Committee, introduced the other members of this committee  
Mrs. A. A. Jones introduced the other members of the Ladies' Local Arrangements Committee

Moved by C. H. Bailey that a telegram be sent L. R. Olsen expressing our sympathy with him in his father's illness. Seconded, carried.

Moved by R. S. Herman that a telegram be sent to C. J. Paterson and E. E. Werner expressing our sympathy with them in their serious illnesses. Seconded, carried

Foreign members and guests of the association were introduced, also the membership by local sections.

Appointment of convention committees by the President:

Nominating committee: R. W. Mitchell, chairman; W. C. Meyer, Mary M. Brooke, Julius Hendel, R. B. Potts

Resolutions committee: C. B. Kress, chairman; Betty Sullivan, L. E. Leatherrock

Auditing committee: R. K. Durham, chairman, R. L. Frye, H. J. Fleming

R. J. Clark, for the Program Committee, explained the operation and details of the program, papers, etc.

\*President's address, by C. E. Mangels

Hugo Roos extended an invitation from M. F. Dillon to all A. A. C. C. members to attend the thirty-fourth Annual Convention of the Association of Operative Millers in St. Louis, June 3-8, 1929.

Meeting adjourned at 12:15 p.m. for lunch in honor of the charter members of the association: C. F. Buck, R. W. Mitchell, A. W. Esterbrook, P. M. Patterson, J. M. Hogan, A. A. Jones, A. R. Sasse, R. A. Lusk, H. E. Weaver, E. G. Wahlin

Meeting called to order at 2:00 p.m. by President Mangels

Greetings read from A. A. Jones and L. R. Olsen

Meeting then placed in charge of temporary Chairman, C. G. Harrel

Paper—"Effect of Severe Weathering on the Protein and Ash Contents of Wheat and Flour" by W. O. Whitcomb and Arnold H. Johnson—Discussion

Paper—"Certain Effects of Varying the Hydrogen-Ion Concentration of the Tempering Water upon the Proteins of Wheat" by Max C. Markley  
C. G. Harrel presented "The Dough Boys in Action"; a nine-act movie play by The Fluky Film, Inc. Well received

Paper—"Loaf Volume as Produced by Different Flours Under Prolonged Dough Fermentation" by R. J. Clark. Good discussion

Paper—"Points of Consideration in Baking Tests" by C. G. Harrel

Meeting adjourned at 6:00 p.m.

At 8 p.m. C. G. Harrel presented an illustrated lecture displaying the work done by the Baking Committee during the year

#### Tuesday, May 7

Meeting called to order at 8:45 a.m. by President Mangels

Communication from F. H. Loomis read

Meeting then placed in charge of temporary chairman, C. G. Harrel

Report of Committee on Standardization of the Experimental Baking Test, by C. G. Harrel

Sub-report by C. H. Bailey, "Statistical Analysis of the Collaborative Baking Results Obtained"

Sub-report by L. D. Whiting, "Minutes of the Meeting Held by the Committee"

Sub-report by C. G. Harrel, "Statement of the Expenses and Activities of the Committee"

Sub-report by M. J. Blish, "External and Internal Characteristics"

Sub-report by R. J. Clark, "Yeast Testing Method"

Sub-report by Emily Grewe, "Oxidation and Reduction Potential"

Sub-report by G. Moen, "Molding and Panning"

Sub-report by C. G. Harrel, "Results of Questionnaire"

Sub-report by W. L. Heald, "Relation of Supplement C to the Other Optional Methods of the Baking Test"

Sub-report by R. C. Sherwood, "Dough Thermometers"

Sub-report by C. G. Harrel, "Baking Ovens"

Sub-report by L. D. Whiting, "Baking Pans"

Sub-report by A. A. Towner, "Use of Covers During Fermentation and Proofing"

Sub-report by W. L. Heald, "Loaf Volume Boxes"

Sub-report by A. A. Towner, "Fermentation and Proofing Cabinets"

A greeting from Kent-Jones was read

Meeting adjourned at 12:10 p.m.

#### Wednesday, May 8

Meeting called to order at 8:45 a.m. by President Mangels

Moved by L. E. Leatherock that the minutes of the 1928 Minneapolis Convention, as published in Cereal Chemistry, be approved. Seconded, carried.

Moved by W. L. Heald that each committee chairman make a motion to the effect that his own report be approved and accepted. Seconded, carried

#### Report of the Executive Committee

The routine business of the association has been carried on throughout the year without complications.

Mr. Mize, our secretary, deserves considerable credit for the efficient and painstaking manner in which he has conducted his office. His work

has been of the highest order; which, of course, has simplified the problems of the executive committee.

Only two major questions have arisen.

**FIRST: The Selection of a meeting place for the present convention**

You will remember that Detroit, Mich., was a favorite when the sense of the meeting was taken last year, but after careful consideration, the executive committee decided that Kansas City was the logical location, as this is our fifteenth anniversary and therefore it is right and fitting that the convention be held in the home city.

It has been several years since a meeting was held here.

A large proportion of the membership is located in and around Kansas City, and the fact that we were to meet a month earlier than usual was also another inducement, as this climate during May is more desirable than that of the other cities that were considered.

Last, but not least, our local membership in Kansas City was very insistent that we meet with them, thereby assuring us an active local committee.

I believe we can all agree that the final decision was in the best interests of the association.

**SECOND: Regarding the Book of Methods**

At the close of the previous year we had 36 copies in the hands of the secretary, with all orders filled. To our surprise, this stock was quickly exhausted. Orders began to accumulate and we were faced with the necessity of printing an additional supply.

As there had been more or less criticism of the first issue, on account of errors—arrangement of tables, difficulty in locating subjects, etc., it was decided to adopt the following program:

Print an index for the new issue

Rearrange the protein tables

Print an additional 500 copies of each to be sent to all previous subscribers.

Correct typographical errors

Insert chapter, title, and page number in part I of the second printing

Add the page number to each cross-reference in the second printing

We carefully considered the question of expense in connection with these changes, but the book as it now stands, while still open for improvement, will be much more acceptable to the subscribers as well as more creditable to the association.

As an association, we felt we could not afford to let any of our official publications go out to members or others interested unless the material was properly arranged and the information as reliable and free from error as humanly possible.

At this time I want to convey the thanks of the executive committee to Drs. Sherwood and Collatz and C. L. Brooke for their painstaking work in connection with these changes.

I want to express my own appreciation for the splendid co-operation received from all members of the executive committee—Rowland J. Clark, Leslie R. Olsen, and Geo. L. Alexander.

There has been a slight increase in membership throughout the year. The spirit of the organization is excellent and we can assure you that the association is in a healthy condition.

M. A. Gray, Chairman

G. L. Alexander

R. J. Clark

L. R. Olsen

Executive Committee

Moved and seconded that the report be accepted. Carried.

Moved by M. A. Gray that a check of \$100 be drawn on the association in favor of M. D. Mize as a token of appreciation of his work during the year. Seconded, carried.



Report of committee on allied associations, by H. E. Weaver, who told of the inactivity of this committee.

Report of membership committee, by C. B. Kress, C. T. Newell, and L. E. Leatherock, who told of the progress made during the year.

#### **Report of Publicity Committee**

L. D. Whiting, Chairman

The publicity committee, consisting of Messrs. Swanson, Clark, Logue, and Micka, in addition to the chairman, has been engaged during the last year in the following activities:

1. The trade journals have been promptly supplied with News Letters of the association. In sending out these News Letters, of which there were four, 110 letters were written. At present 29 journals and periodicals are on the mailing list.

2. Numerous articles of interest to cereal chemists, written by our members or concerning our members, have been clipped, and have been added to the Clipping book, which was started last year by R. J. Clark. This book may prove of interest to future association historians.

3. The columns of the press have been carefully observed with the idea of correcting any glaringly mistaken statement in regard to cereal chemists, or cereal chemistry.

4. Abstracts of 13 of the papers delivered at this convention have already been sent to the 29 journals on the mailing list.

Moved and seconded that the report be accepted. Carried.

#### **Report of Committee on Award of the Osborne Medal**

R. A. Gortner, Chairman

Your committee has handled its business this year by correspondence, and in one of the News Letters requested nominations from members of the association for persons who should be considered as recipients of the Osborne Medal.

Two nominations have been received from independent sources, the same person being nominated in each instance. In correspondence within the committee and in view of the financial obligations involved, the committee felt that it would be wise to defer a second award of the medal until at least the 1930 convention. This reaction of the committee is based upon two grounds: (1) The feeling that the medal should be awarded only to outstanding leaders in the field of cereal chemistry, and (2) that the awards should not be sufficiently often as to cheapen the honor that the medal confers.

Providing the condition of the treasury of the association is such as to warrant the award of the medal in 1930, your committee will actively proceed in that direction.

Again your committee wishes to emphasize the fact that it will welcome nominations of persons deemed by any member of the association worthy of the award of the medal. We can function to the best advantage of the association only if every member who knows of an outstanding contribution of some person will communicate his beliefs to the committee.

Moved and seconded that the report be accepted. Carried.

#### **Report of History Committee**

R. W. Mitchell, Chairman

We hand to you at this time a rather complete outline of the growth and development of the American Association of Cereal Chemists. It is, however, merely an outline and is submitted for your criticism and comment and we hope, your suggestions, for the guidance of your future committee.



We ask that the executive committee consider the material in this report and exercise the privilege of indicating to the succeeding committee any changes in style that seem desirable.

We trust that this report, while showing the work far from complete, may be found to be a suitable framework on which to build a history that will meet with the approval of the society in every way.

Moved and seconded that the report be accepted. Carried.

### **Report of Auditing Committee**

R. K. Durham, Chairman

Your auditing committee reports that it has examined the accounts of the secretary-treasurer and has, so far as practical, verified the entries therein, reconciled cash on hand, building and loan stock, and savings accounts with that actually existing in the various depositories and finds the accounts of the secretary-treasurer regular in every respect. The secretary-treasurer has kept his records in accurate and systematic order.

Moved and seconded that the report be accepted. Carried.

### **Report of Managing Editor**

The financial statement of the secretary-treasurer gives the balance in the Cereal Chemistry account at close of business April 30, 1929.

The balance shown at the last accounting is likely to be misleading because a large percentage of the income for Cereal Chemistry for the entire year has been received but only a small percentage of the expenses has been paid. Therefore the report of the managing editor will be devoted principally to the statement of receipts and expenditures for Volume V for the calendar year 1928.

The total income for Volume V, after making adjustments for actual receipts for other volumes, received during 1928, was \$4,774.59. Of this, \$1,594.50 was received from active and corporation members dues. This constitutes 33 per cent of the receipts. Advertising brought an income of \$1,346.00 or 28 per cent of the total. The income from foreign and domestic subscribers was \$1,143.71, approximately the same as the income of dues from active members. This represents 24 per cent of the total. Income from back issues, bound and unbound, was \$407.98, 8 per cent of the total. Reprints brought a gross income of \$256.04, 5 per cent of the total. Interest on Building and Loan stock provided \$60.00 or about 1¼ per cent.

This statement shows that receipts from members and subscribers represent only about 60 per cent of the income. The importance of advertising as a source of income cannot be overemphasized. Members are urged to patronize the advertisers and to mention Cereal Chemistry when writing to them, as such comments impress the advertiser with the value of the journal as an advertising medium. Members are also urged to aid in getting subscriptions. This is your journal. You can help it grow by your active support. Past experience has shown that many subscribers become members in a short time.

The total expenditures for Volume V, 1928, were \$4,566.02. The largest item is the cost of printing the journal, which is \$2,837.22. This is approximately 64 per cent of the expenditures. Reprints cost \$554.92, or 13 per cent of the total expenditures. The cost of reprints donated to the authors was \$300.00; the cost of additional reprints sold to the authors was \$254.92. The receipts from the sale of these reprints barely paid the cost of printing and did not cover the cost of handling invoices and mailing. It will probably be necessary to make a slight advance in the rates for reprints. Miscellaneous printing, stationery, mailing envelopes, etc., cost \$170.23, or 4 per cent of the total expenditures. Editorial expenses, including copy and proof-reading, stenographic work, service of artists on illustrations, addressograph

service, and mailing totaled \$1,173.88, or 25 per cent of the entire expense. Postage for mailing the journal for one year amounted to \$110. Expenditures for Volume V, 1928, deducted from the income for the same volume leave a balance of \$208.57. The number of pages in the volume was 492, 14 pages less than appeared in Volume IV. Volume V had an average of 82 pages per issue, at a cost of \$9.18 per page.

Compared with a year ago, there is a slight increase in the number of subscribers and members, 656 this year, 646 last year. Forty-five former subscribers and 22 former members have not yet remitted for 1929 and part of these may be reinstated. None of these delinquent members and subscribers have received an issue since January, but we are endeavoring to return them to the mailing list. Our mailing list includes 399 members, 56 of whom are in foreign countries. Mr. Mize reports 7 additions since this record was compiled. The subscribers total 257, of whom 147 are foreign. Cereal Chemistry is mailed to about 750.

The cost of printing the journal, figured per page, is mounting. The principal reason for this appears to be the inclusion of more tabular material and more special characters, which require extra expense in printing. Further expansion in size of Cereal Chemistry will depend upon additional income.

—R. C. Sherwood

Moved and seconded that the report be accepted. Carried.

#### Report of the Editor-in-Chief

Only one or two matters of policy have required attention during the last year. It is evident to the editor that the present responsibilities of the managing editor require too much of his time and personal attention. Means must be found for financing the employment of more clerical assistance in his office.

The editors sense a feeling on the part of the trade press that we are being somewhat arbitrary in the matter of declining to release convention papers for publication in journals other than Cereal Chemistry. After careful consideration of all the factors involved we have reached the conclusion that if the journal, with its present income from subscription, is to be maintained, this policy must be continued. Members of the association may properly prepare more articles addressed to an audience of millers and of bakers, however. Such papers should be published in the appropriate trade journals. We solicit, as in the past, papers directed primarily to cereal chemists.

—C. H. Bailey

Moved and seconded that report be accepted. After some discussion of the policies of Cereal Chemistry, motion was carried.

Report of question committee, A. R. Sasse, chairman, stated that all questions were answered without much difficulty.

#### Report of the Secretary-Treasurer

M. D. Mize

May 8, 1929

During the last year several new funds have been established, as follows: An Acidity Research Fund of \$245 was received and disbursed without profit or loss; a Reserve Convention Fund of \$352.78 was received from M. A. Gray, chairman of the Minneapolis 1928 local convention committee, with the understanding that this money was to be kept strictly as a reserve and none of it expended except in case some local committee of some future convention might fail to meet all expenses owing to some unforeseen circumstance; the Book of Methods fund amounts to \$258.68 with all costs of the original edition paid and all books sold. There are 67 orders on hand for the second edition, which has now gone to press and will

be ready for distribution within the next thirty days. One hundred bound volumes and one hundred unbound volumes of this second edition will be printed. Therefore, all members who desire a copy should place their order at once with the secretary-treasurer, for only 23 bound volumes remain for distribution after filling the advance orders.

## DETAILED MEMBERSHIP STATEMENT

	Total	Active	Corporation	Honorary
Membership, June 1, 1928.....	355	309	44	2
New members added .....	63	60	2	1
Members reinstated .....	20	20	0	0
	<hr/> 438	<hr/> 389	<hr/> 46	<hr/> 3
Members resigned .....	12	10	2	0
Members suspended for non-payment of dues .....	22	21	1	0
Members' addresses lost .....	2	2	0	0
Members deceased .....	1	0	0	1
Paid memberships May 1, 1929.....	401	356	43	2
	<hr/> 438	<hr/> 389	<hr/> 46	<hr/> 3
Gain in paid memberships during fiscal year .....	46	47	-1	0

## FINANCIAL STATEMENT

## RECEIPTS

Cash on hand June 1, 1928.....	\$ 824.10
Membership dues:	
Active .....	2745.59
Corporation .....	440.00
Application fees .....	183.00
Cereal Chemistry subs., reprints, back numbers .....	1863.26
Cereal Chemistry advertising .....	1022.00
Interest on Building & Loan stock.....	140.62
Sale of Building & Loan stock.....	1500.00
Acidity Research fund .....	245.00
Reserve Convention fund .....	352.78
Sale of Book of Methods.....	427.57
Miscellaneous receipts .....	30.24

## TOTAL RECEIPTS .....

\$9774.16

## DISBURSEMENTS

Osborne medal .....	\$300.00
Purchase of Building & Loan stock.....	1500.00
Convention expense .....	8.00
Gift to President .....	25.00
Gift to Secretary .....	175.00
Commission of advertising to Managing Editor.....	110.20
Editing, printing, and mailing Cereal Chemistry.....	2862.02
Reprints .....	470.37
Printing of Osborne Medal Brochure .....	127.03
Expense of president's office and News Letters.....	241.72
Expense of secretary-treasurer's office .....	289.40
Book of Methods .....	100.57
Acidity research .....	245.00
Miscellaneous expense .....	546.47

## TOTAL DISBURSEMENTS .....

\$7000.78

## CASH ON HAND MAY 1, 1929.....

\$2773.38

## ASSETS

Cash on hand:	
U. S. National Bank, Savings Dept.....	\$1000.00
First National Bank, Savings Dept.....	500.00
Cash in U. S. National Bank.....	806.62
Checks being collected .....	24.00
Cash in Intercity State Bank .....	442.76
	<hr/> \$2773.38
Petty cash fund in Minneapolis .....	100.00
Building & Loan stock in Kansas City .....	2000.00
Building & Loan stock in Omaha .....	1500.00

## TOTAL ASSETS .....

\$6373.38

## TOTAL LIABILITIES .....

0.00

The above statement of assets really means very little; most of the 1929 revenue has been received but very few of the 1929 expenses have been incurred or paid. I am, therefore, listing below a statement of the assets on December 1, 1928, for on that date practically all of the 1928 revenue had been received and all but a few of the 1928 expenses had been paid.

## ASSETS AS OF DECEMBER 1, 1928

## CASH ON HAND:

U. S. National Bank, Savings Dept. ....	\$1000.00
First National Bank, Savings Dept. ....	500.00
Cash in U. S. National Bank .....	47.67
Checks out for collection .....	3.50
Cash in Intercity National Bank .....	442.76
	<hr/>
	\$1993.93
Petty cash fund in Minneapolis .....	100.00
Building & Loan stock in Kansas City .....	2000.00
	<hr/>
TOTAL ASSETS .....	\$4093.93

Total liabilities are about \$1000, which includes the cost of editing and printing the November, 1928, issue of Cereal Chemistry and other miscellaneous expenses incurred during the year, but not yet paid.

To divide the assets on hand December 1, 1928, in the following manner might really mean more to most members:

Cereal Chemistry assets .....	\$2944.08
Association assets .....	420.64
Book of Methods reserve fund .....	246.43
Acidity research fund .....	130.00
Reserve convention fund .....	352.78
	<hr/>
TOTAL ASSETS .....	\$4093.93

Moved and seconded that the report be accepted. Carried.

Election of officers.

The following officers were elected:

President, M. A. Gray

Vice-president, C. G. Harrel

Secretary-treasurer, M. D. Mize

Editor-in-chief, C. H. Bailey

Managing editor, R. C. Sherwood

Moved by Pearl Brown that a rising vote of thanks be given the outgoing president, C. E. Mangels. Seconded, carried.

Invitations for the 1930 convention were received from several cities. From a ballot taken for the purpose of advising the executive committee of the choice of the members present, the following vote was obtained: Detroit 31, Colorado Springs 30, Toledo 14, Chicago 10, St. Louis 6, Buffalo 2.

Telegram from Dr. E. E. Werner received and read.

C. G. Harrel moved that the report of the baking committee be accepted. Seconded, carried.

C. G. Harrel moved that the association authorize the executive committee to raise money for the establishment of a fellowship fund to continue the work with the experimental baking test. Seconded, carried.

H. A. Baehr made the suggestion that the work of standardizing the size of Kjeldahl flasks be taken up by the methods committee during the year.

It was suggested that the next convention be provided with a projection lantern for the purpose of showing printed matter as well as slides.

J. T. Flohil moved that, whereas, the Northwest section, through its methods and sampling committee, have been instrumental in sending out 80 flour samples to its members and to the members of other sections for the purpose of obtaining reports on protein, ash, and moisture; and, whereas, the co-operation of the different sections with the Northwest section has been very gratifying; and, whereas, many letters have been received expressing the desire to continue such efforts; be it moved that the methods com-

mittee supervise such work and establish a policy for distributing the cost of sending out 4 such samples a year—Discussion.

A. E. Treloar moved that the motion be tabled. Seconded, carried.

Meeting adjourned to 11:45 a.m.

#### Thursday, May 9

Meeting called to order at 8:45 a.m. by President M. A. Gray

E. E. Smith, temporary chairman, then took charge of the morning program

Report of committee on methods of testing cake and biscuit flours, by Mary M. Brooke, chairman

Sub-report by G. L. Alexander, "Cake Testing Formula"

Sub-report by A. W. Meyer, "Viscosity Tests on Soft Wheat Flour"

Sub-report by L. E. Jackson, "A Score Card for Test Cake"

Moved by Mary M. Brooke that the report be adopted as read. Discussion, seconded, passed

Paper—"Evaluating Wheat Varieties by Co-operative Tests," by C. O. Swanson

Paper—"Discussion of C. O. Swanson's Paper," by J. H. Parker, Agronomy Department, Kansas State Agricultural College, Manhattan, Kans.

Paper—"Fermentation Tolerance," by E. B. Working, read by C. O. Swanson

Paper—"The Prediction of Loaf Volume," by A. E. Treloar—Discussion

Several communications read

Meeting adjourned at 12:07 p.m. Annual picnic at Hoffdale during afternoon

#### Friday, May 10

Meeting called to order at 8:45 a.m. by President M. A. Gray

Report of committee on methods of analysis, by M. J. Blish, chairman

Sub-report by L. H. Bailey, "Indicators for Protein Determinations"

Sub-report by A. E. Treloar, "Statistical Study of Collaborative Protein Analysis"

Moved by M. J. Blish that the committee's recommendations be accepted. Seconded, carried

Appointment of committees for ensuing year by President Gray

Executive committee: C. G. Harrel, chairman, C. E. Mangels, L. D. Whiting, L. R. Olsen

Committee on allied associations: L. R. Olsen, chairman, H. E. Weaver

Membership committee: C. B. Kress, chairman, Fred D. Patterson, Bert Ingels, W. A. Richards, S. J. Lawellin, L. E. Leatherock, Harry D. Liggett, T. R. Aitken

Committee on methods of analysis: John T. Flohil, chairman, R. K. Durham, W. C. Meyer, J. A. Le Clerc, A. E. Treloar, F. A. Collatz

Committee on standardization of laboratory baking: C. H. Bailey, chairman, C. G. Harrel, R. J. Clark, M. J. Blish, H. E. Weaver

Committee on methods of testing cake and biscuit flours: Mary M. Brooke, chairman, J. A. Dunn, L. H. Bailey, C. H. MacIntosh, E. E. Smith, G. L. Alexander, V. E. Fisher, C. A. Armstrong, L. E. Jackson, C. B. Kress

Committee on employment: C. B. Morison, chairman, M. D. Mize, R. B. Potts

Committee on publicity: J. A. Dunn, chairman, Paul Logue, C. O. Swanson, W. C. Meyer, Pearl Brown

Committee on Osborne medal awards: R. A. Gortner, chairman, C. L. Alsberg, A. R. Sasse, R. W. Stark

Question committee: Julius Hendel, chairman, Betty Sullivan, L. H. McLaren, Hugo Roos, M. F. Dillon

Special committee on flour specifications: F. A. Collatz, chairman, J. T. Flohil, C. H. Bailey, L. R. Olsen

History committee: R. W. Mitchell, chairman, J. A. LeClerc, S. J. Lawellin



M. A. Gray announced that the executive committee approved the issuing of charter 6 to the Buffalo Frontier local section of the association

C. G. Harrel placed the proposal for the raising of funds for the baking fellowship before the convention; issued subscription blanks and collected donations from the active members present

Report of acidity research committee, by F. A. Collatz, chairman, read by C. H. Bailey

Moved by C. H. Bailey that the recommendations of the committee be accepted. Seconded, carried.

Paper—"The Acidity Method with Special Reference to the Acidity Limits Imposed by the Greek Government," by C. L. Brooke and C. H. Bailey

Paper—"The March of Acidity in Stored Flour," by C. C. Fifield and C. H. Bailey

Paper—"Determination of Ash from the Direct Weight of the Ash," by J. L. Spalding

Paper—"Quick Ash Determination by the Magnesium-Acetate-Alcohol Method," by J. L. Spalding

Paper—"The Adaptability of the Quinhydrone Electrode to Cereal Work," by L. V. Sorg

Meeting adjourned at 12:05 p.m. for luncheon in honor of the new officers of the association

Meeting called to order at 2:05 p.m. by President Gray

Paper—"Sundry Means of Hastening the Determination of Protein," by H. L. Wilkins

Meeting then placed in charge of L. H. McLaren, temporary chairman

Paper—"Proteolysis in Bread Dough," by W. E. Brownlee and C. H. Bailey

Paper—"Hydrogen-Ion Determination in Flour and Bakery Products," by Emily Grewe and E. O. Whittier

#### Report of Committee on Resolutions

Be it resolved that this association express its thanks and gratitude to the Kansas City Chamber of Commerce for its kindness in furnishing our convention programs.

Be it resolved that we express our thanks to the Rev. I. M. Hargett, of Kansas City, for his delivery of the invocation at the opening of our convention.

Be it resolved that we commend the program committee for the excellent program presented this year, and that we express our approval of their method of having short papers followed by a general discussion.

Be it resolved that we acknowledge our debt of gratitude to all committee members, including the experimental baking test committee, the cake and biscuit flour committee, the committee on methods of analysis, the committee on flour specifications for their extensive collaborative studies carried out during the last year.

Be it resolved that the sincere thanks of this association be expressed to the members of the local arrangements committee for their excellent work in providing for our entertainment, especially to the ladies who have so ably assisted.

Be it resolved that we extend our most sincere thanks to the officers of this association and to the editors of "Cereal Chemistry," who have all devoted a lavish amount of time and labor in furthering our interests as an association, and in maintaining the high standard of our publication "Cereal Chemistry" which has grown in influence until it now commands world-wide respect.

Be it resolved that the thanks of this convention be tendered to the management of the Hotel President for their courteous treatment and the excellent service they have rendered.



WHEREAS, since our last meeting one of our co-workers in Cereal Chemistry, Thomas Burr Osborne, has completed his life work and been taken from our ranks, we herewith express our sorrow, and our appreciation for his most valuable contributions to the science of cereal chemistry. We owe much to Dr. Osborne. His pioneer work has inspired us to look deeper into the secrets of nature and has laid the foundation for some of our most important scientific achievements. We can well be proud to have claimed him as an associate.

Be it resolved that we extend greetings and best wishes to our fellow workers in the Association of Operative Millers, the Millers National Federation, the American Society of Bakery Engineers, and the American Bakeries Association; that we pledge to them our most hearty co-operation in all matters for the common good of our industry.

Be it resolved that we express to T. L. Hoffman and W. H. Thompson our appreciation for the wonderful entertainment provided for us on our picnic at Hoffdale. Our best wishes to you, Mr. Hoffman and Mr. Thompson.

C. B. Kress, Chairman  
Betty Sullivan  
L. E. Leatherock  
Resolutions Committee

Moved that the report be accepted. Seconded, carried.

C. E. Mangels moved that a vote of thanks be extended to C. G. Harrel, E. E. Smith, and L. H. McLaren, who have acted as temporary chairmen during the convention, for their assistance to the officers. Seconded, carried.

R. K. Durham reported that the registration fee successfully met all expenses incurred during the convention by the local arrangements committee.

The convention was adjourned by President Gray at 3:25 p.m.

## REGISTRATION AT CONVENTION, KANSAS CITY, MISSOURI

MAY 6-10, 1929

### Members

H. Adler, Victor Chemical Works, Chicago, Ill.  
T. R. Aitken, Dominion Grain Research Lab., Winnipeg, Manitoba  
G. L. Alexander, Commercial Milling Company, Detroit, Mich.  
C. A. Armstrong, Iglehart Bros., Evansville, Ind.  
H. A. Baehr, Topeka Flour Mills Corp., Topeka, Kans.  
C. H. Bailey, University of Minnesota, St. Paul, Minn.  
Lorin H. Bailey, Bureau of Chemistry & Soils, U. S. Dept. of Agr., Wash.  
R. C. Benson, Pillsbury Milling Co., Minneapolis, Minn.  
W. L. Bergman, Industrial Appliance Co., Chicago, Ill.  
Jerry Billings, Quality Bakers of America, New York City  
M. J. Blish, University of Nebraska, Lincoln, Nebr.  
J. A. Bourne, Junge Baking Co., Joplin, Mo.  
D. L. Boyer, Provident Chemical Works, St. Louis, Mo.  
Murray E. Brierly, Harvest Queen Mill, Plainview, Texas  
C. L. Brooke, Pillsbury Flour Mills Co., Minneapolis, Minn.  
Mrs. Mary M. Brooke, Purity Bakeries Corp., Chicago, Ill.  
Pearl Brown, Perfection Biscuit Co., Ft. Wayne, Ind.  
W. E. Brownlee, University of Minnesota, Minneapolis, Minn.  
Geo. H. Buford, Globe Mills, Ogden, Utah  
H. M. Butler, Willis-Norton, Topeka, Kans.  
F. Carr, Southwestern Lab., Kansas City, Mo.  
Lee E. Clark, Kansas City Lab. Supply Co., Kansas City, Mo.  
R. J. Clark, Schulze Baking Co., Kansas City, Mo.  
F. A. Collatz, General Mills, Inc., Minneapolis, Minn.

- D. E. Colwell, Kansas State Grain Dept., Wichita, Kans.  
A. E. Curtis, Midland Flour Milling Co., Kansas City, Mo.  
Frank N. Cyr, Gen. Mills, Inc., Minneapolis, Minn.  
G. A. Davis, Pillsbury Milling Co., Atchison, Kans.  
Claud F. Davis, Western Star Mill, Salina, Kans.  
M. F. Dillon, Secy.-A.O.M., Kansas City, Mo.  
F. L. Dunlap, Industrial Appliance Co., Chicago, Ill.  
J. A. Dunn, Procter & Gamble, Cincinnati, Ohio  
R. K. Durham, Rodney Milling Co., Kansas City, Mo.  
C. C. Fifield, University Farm, St. Paul, Minn.  
G. E. Findley, Morton Milling Co., Dallas, Texas  
V. E. Fisher, Stanard Tilton Milling Co., Alton, Ill.  
H. J. Fleming, Nebraska Consolidated Mills Co., Omaha, Nebr.  
T. G. Fletcher, Wichita Mill & Elev. Co., Wichita Falls, Texas  
J. T. Flohil, Pillsbury Flour Mills, Minneapolis, Minn.  
L. H. Fratzke, Western Flour Mills, Davenport, Iowa  
R. I. Friasbie, Control Quimico A. & I., Mexico City, Mexico  
Rolfe L. Frye, Valier-Spies Milling Co., St. Louis, Mo.  
W. F. Geddes University of Manitoba, Winnipeg, Manitoba  
Phillip Goldfisch, Laboratory Construction Co., Kansas City, Mo.  
O. E. Gookins, Quaker Oats Co., St. Joseph, Mo.  
M. A. Gray, Pillsbury Flour Mills, Minneapolis, Minn.  
N. L. Gregory, Maple Leaf Milling Co., Port Colborne, Ontario, Canada  
Emily Grewe, Bureau of Dairy Industry, Washington D. C.  
C. B. Gustafson, Soft Wheat Millers Assn., Nashville, Tenn.  
Henry W. Hahn, Gilster Milling Company, Steelville, Ill.  
C. R. Harlow, Pillsbury Flour Mills Co., Enid, Okla.  
C. G. Harrel, Bakeries Service Co., Jamaica, N. Y.  
W. L. Heald, Larabee Flour Mills, Kansas City, Mo.  
Julius Hendel, Cargill Elevator Co., Minneapolis, Minn.  
Chas. J. Henry, Hecker-Jones-Jewell Milling Co., Buffalo, N. Y.  
R. S. Herman, Washburn-Crosby Milling Co., Buffalo, N. Y.  
John P. Holt, 822 Buchanan, Topeka, Kans.  
Geo. L. Howard, Moore & Lowry Flour Mills, Kansas City, Mo.  
L. E. Jackson, Victor Chemical Works, Chicago, Ill.  
H. H. Johnson, Gooch Milling Co., Lincoln, Nebr.  
J. H. Julicher, Pillsbury Flour Co., Buffalo, N. Y.  
C. B. Kress, Sperry Flour Co., San Francisco, Calif.  
A. L. Lancaster, Blair Milling Co., Atchison, Kans.  
S. J. Lawellin, Wallace & Tiernan Co., Newark, N. J.  
L. E. Leatherock, Kansas Milling Co., Wichita, Kans.  
J. A. LeClerc, U. S. Dept. of Agr., Washington, D. C.  
P. Logue, Provident Chemical Works, St. Louis, Mo.  
Fred J. Lumsden, King Midas Milling Co., Minneapolis, Minn.  
C. H. MacIntosh, C. J. Petterson Corp., Kansas City, Mo.  
L. H. McLaren, Shellabarger Mill & Elev. Co., Salina, Kans.  
A. MacLeod, Canadian Wheat Pool, Winnipeg, Manitoba  
Nell McNeil, Southwestern Lab., Kansas City, Mo.  
C. E. Mangels, No. Dak. Agr. College, Fargo, No. Dak.  
M. C. Markley, Slater Mill & Elev. Co., Slater, Mo.  
R. S. Mather, Kansas Mill & Elev., Arkansas City, Ark.  
Paul P. Merritt, Larabee Flour Mills Co., Kansas City, Mo.  
A. W. Meyer, The W. E. Long Co., Chicago, Ill.  
W. C. Meyer Ismert-Hincke Milling Co., Kansas City, Mo.  
V. Wallace Mitchell, American Bakery Materials Co., Menomonie, Wisc.  
M. D. Mize, Omaha Grain Exchange, Omaha, Nebr.  
G. Moen, Washburn-Crosby Milling Co., Minneapolis, Minn.  
Claud L. Moore, Washburn-Crosby, Inc., Buffalo, N. Y.  
W. J. Mullen, Novadel-Agene, Newark, N. J.

- C. M. Murphy, Goerz Flour Mills Co., Newton, Kans.  
C. E. Newell, Burrus Mill & Elev. Co., Ft. Worth, Texas  
F. X. Nodler, Plant Flour Mills, St. Louis, Mo.  
A. G. Olsen, The Postum Co., Battle Creek, Mich.  
C. O. Oppen, Lawrenceburg Mill, Lawrenceburg, Ind.  
E. M. Paget, Rumford Chemical Works, Chicago, Ill.  
E. E. Palmer, Hubbard Milling Co., Mankato, Minn.  
Paul Panderally, Southwestern Milling Co., Kansas City, Mo.  
L. H. Patten, State Mill & Elev. Co., Grand Forks, N. D.  
F. D. Patterson, Texas Star Flour Mills, Galveston, Texas.  
Earl C. Paulsel, International Milling Co., Minneapolis, Minn.  
George E. Plange, Harburg-Wilhelmsburg-Hord, Hamburg, Germany  
R. B. Potts, Wichita Flour Mills, Wichita, Kans.  
Roger W. Pratt, Wallace & Tiernan, Kansas City, Mo.  
Glenn L. Pyle, Consolidated Flour Mill Co., Wichita, Kans.  
W. L. Rainey, Larabee Flour Mills Co., St. Joseph, Mo.  
R. R. Renick, Iliff Bruff Chemical Co., Hoopeston, Ill.  
W. A. Richards, International Milling Co., Buffalo, N. Y.  
C. H. Robinson, Dept. of Agriculture, Ottawa, Canada  
S. N. Rogers, Page Milling Co., Topeka, Kans.  
Hugo Roos, Modern Miller, Kansas City, Mo.  
Perle Rumold, Southwestern Milling Co., Kansas City, Mo.  
T. W. Sanford, Eagle Roller Mill Co., New Ulm, Minn.  
A. R. Sasse, Southwestern Milling Co., Kansas City, Mo.  
J. S. Schlesinger, H. D. Lee Flour Mills, Salina, Kans.  
A. S. Schultz, Fleischman Yeast Co., New York, N. Y.  
Paul Sherrick, Central Scientific Co., Chicago, Ill.  
R. C. Sherwood, State Testing Mill, Minneapolis, Minn.  
V. Shiple, National Milling Co., Toledo, Ohio  
H. L. Shirk, G. B. R. Smith Milling Co., Sherman, Texas  
Miss Elise C. Shover, American Bakeries Co., Atlanta, Ga.  
E. J. Slesser, Commander Milling Co., Minneapolis, Minn.  
Edw. E. Smith, F. W. Stock & Sons, Hillsdale, Mich.  
E. D. Soesman, Maple Leaf Milling Co., Medicine Hat, Alberta  
C. J. Sommerville, Southwest Corp. Wheat Growers, Leavenworth, Kans.  
J. L. Spalding, Larabee Flour Mills Co., Wellington, Kans.  
Geo. Stadler, Maney Milling Co., Omaha, Nebr.  
W. H. Strowd, National Soft Wheat Millers Assn., Nashville, Tenn.  
M. L. Sudsberry, Wallace & Tiernan Co., Newark, N. J.  
Betty Sullivan, Russell-Miller Milling Co., Minneapolis, Minn.  
C. O. Swanson, Kansas State Agr. College, Manhattan, Kans.  
G. Cullen Thomas, General Mills, Inc., Minneapolis, Minn.  
E. F. Tibbling, Washburn-Crosby Milling Co., Kansas City, Mo.  
W. M. Tinkham, Washburn-Crosby Milling Co., Minneapolis, Minn.  
A. A. Towner, Red Star Milling Co., Wichita, Kans.  
Allan E. Treloar, Sydney, Australia (Univ. of Minn., St. Paul)  
W. V. VanScoyk, Larabee Flour Mills Co., Hutchinson, Kans.  
H. F. Vaupel, El Reno Mill & Elev. Co., El Reno, Okla.  
S. N. Vilm, Enid Milling Co., Enid, Okla.  
E. L. Von Eschen, Bakeries Service Corp., Kansas City, Mo.  
Clarence Ward, Hunter Milling Co., Wellington, Kans.  
H. E. Weaver, Kansas Flour Mills Corp., Kansas City, Mo.  
J. W. Whitacre, Larabee Flour Mills Co., Kansas City, Mo.  
W. O. Whitcomb, Montana Experiment Station, Bozeman, Mont.  
A. G. Whiteside, Dept. of Agr., Ottawa, Canada  
L. D. Whiting, Ballard & Ballard Co., Louisville, Ky.  
H. M. Wight, American Maid Flour Mill, Houston, Texas  
A. D. Wilhoit, Wilhoit Lab., Minneapolis, Minn.  
H. W. Winkler, Hall Milling Co., St. Louis, Mo.

E. Ziegler, Bern, Switzerland

D. H. Ziel, Noblesville Milling Co., Noblesville, Ind.

### Visitors and Guests

N. T. Cunningham, Raiston Purina Co., St. Louis, Mo.

Otis B. Durbin, Purity Bakers Company, Chicago, Ill.

N. C. Evans, National Miller, Chicago, Ill.

R. M. Finch, Wallace & Tiernan Co., Minneapolis, Minn.

G. R. Gillette, Loose-Wiles Biscuit Co., Long Island City, N. Y.

H. L. Grapp, Dispatch Oven Co., Minneapolis, Minn.

Edgar Karbach, Missouri State Grain Inspection, Kansas City, Mo.

B. H. Kepner, Royal Milling Co., Great Falls, Mont.

R. Kufeld, Walnut Creek Mills, Great Bend, Kans.

T. H. Lawson, Kansas Flour Mills, Kansas City, Mo.

L. Maher, Larabee Mills, Clinton, Mo.

C. P. May, Zenith Milling Co., Kansas City, Mo.

H. L. Osborne, Oklahoma City Mill & Elev. Co., Oklahoma City, Okla.

T. C. Roberts, General Mills, Inc., Minneapolis, Minn.

J. A. Strang, Wallace & Tiernan Co., Kansas City, Mo.

F. L. Talmage, Ismert-Hincke Milling Co., Kansas City, Mo.

James D. Veron, Anheuser-Busch, St. Louis, Mo.

Henry Vilm, Southwestern Milling Co., Kansas City, Mo.

John Whinery, Rodney Milling Co., Kansas City, Mo.

Mrs. C. A. Armstrong, Evansville, Ind.

Mrs. Jack Balmer, Minneapolis, Minn.

Mrs. M. J. Blish, Lincoln, Nebr.

Mrs. J. A. Bourne, Joplin, Mo.

Mrs. Lee Clark, Kansas City, Mo.

Mrs. R. J. Clark, Kansas City, Mo.

Mrs. D. E. Colwell, Wichita, Kans.

Mrs. N. T. Cunningham, St. Louis, Mo.

Mrs. A. E. Curtis, Kansas City, Mo.

Mrs. C. F. Davis, Salina, Kans.

Mrs. R. K. Durham, Kansas City, Mo.

Mrs. G. E. Findley, Dallas, Texas

Mrs. R. I. Friebie, Mexico City, Mex.

Mrs. R. L. Frye, St. Louis, Mo.

Mrs. W. F. Geddes, Winnipeg, Manitoba

Mrs. O. E. Gookins, St. Joseph, Mo.

Mrs. M. A. Gray, Minneapolis, Minn.

Mrs. Mildred Harrel, Tulsa, Okla.

Mrs. R. S. Herman, Buffalo, N. Y.

Mrs. J. A. Jones, Kansas City, Mo.

Mrs. S. J. Lawellin, Newark, N. J.

Mrs. L. E. Leatherock, Wichita, Kans.

Mrs. L. H. McLaren, Salina, Kans.

Mrs. M. C. Markley, Slater, Mo.

Mrs. R. S. Mather, Arkansas City, Ark.

Mrs. W. C. Meyer, Kansas City, Mo.

Mrs. R. W. Mitchell, Menomonie, Wisc.

Mrs. M. D. Mize, Omaha, Nebr.

Mrs. G. Moen, Minneapolis, Minn.

Mrs. F. X. Nodler, St. Louis, Mo.

Mrs. E. C. Paulsel, Minneapolis, Minn.

Mrs. R. B. Potts, Wichita, Kans.

Mrs. R. W. Pratt, Kansas City, Mo.

Mrs. Glenn L. Pyle, Wichita, Kans.

Mrs. Hugo Roos, Kansas City, Mo.

Mrs. Perie Rumold, Kansas City, Mo.

Miss Nora N. Sanders, Kansas City, Mo.

Mrs. T. W. Sanford, New Ulm, Minn.

Mrs. A. R. Sasse, Kansas City, Mo.

Mrs. J. S. Schlesinger, Salina, Kans.

Mrs. V. Shipley, Toledo, Ohio

Mrs. H. L. Shirk, Sherman, Texas

Mrs. E. J. Sisser, Minneapolis, Minn.

Mrs. C. O. Swanson, Manhattan, Kans.

Mrs. A. A. Towner, Wichita, Kans.

Mrs. H. F. Vaupel, El Reno, Okla.

Mrs. Harry E. Weaver, Kansas City, Mo.

Mrs. John Whinery, Kansas City, Mo.

Mrs. J. W. Whitacre, Kansas City, Mo.

Mrs. H. W. Winkler, Afton, Ill.

**ADDRESS OF THE PRESIDENT****C. E. Mangels***(Read at the Convention May, 1929)*

Fourteen years ago, on this day (May 8, 1915) in this city (Kansas City) eleven mill chemists met and organized the American Association of Cereal Chemists. From this small beginning has grown our present splendid organization. The American Association of Cereal Chemists since organization has had a continuous steady growth, not only in numbers, but also in influence and prestige. The growth and development of the organization within the last fourteen years shows that there is a real place and need for such an association.

The American Association of Cereal Chemists from its inception has been a strictly scientific society maintained for the exchange of ideas and the advancement of knowledge in the field of cereal chemistry. We owe a debt of gratitude to the charter members of this association, who so successfully directed the affairs of the organization in those precarious early years and who were directly responsible for the high ideals of this association. A majority of our charter members are still active in the work of the association and are now men in the prime of life. Fourteen years ago, these men were youthful chemists starting upon their respective careers. The founders of this association must have had, therefore, in a large degree, the courage, the altruism, and the high ideals of youth, and were not handicapped by the petty jealousies, the narrow prejudices, and the out-worn dogmas of an older generation. These high ideals of our charter members have continued to prevail, and have become an integral part of this association.

It has required a real courage to attempt the solution of some of the problems that have confronted cereal chemists—a courage which has seen the obstacles ahead, but has looked over and beyond toward the goal to be attained. It has required real courage to consign to the scrap-heap methods and theories which had been accepted for a generation or even longer. The records of achievements show that this association has ever sought out the truth. Truth has always freed the scientist from the shackles of age-old theories and superstitions, and seeking out the truth at all costs has greatly contributed to the progress of this association. Much of the progress and advancement in the field of cereal chemistry during the last fourteen years can very properly be ascribed to the far-reaching influence of the courageous spirit and the high ideals of this association. Let us hope that in the future it will continue to maintain the high ideals and progressive spirit of the last fourteen years.

The American Association of Cereal Chemists also owes a debt of gratitude to two business men who by financial aid and enthusiastic support made possible the founding of the association. I refer to Mr. Theodore Ismert and Mr. F. D. Larabee. Both these men have since passed to the great beyond, but their contribution to the establishment of this association will always be remembered.

**Development of a Scientific Journal**

The American Association of Cereal Chemists has continuously fostered and encouraged research in the field of cereal chemistry. One of the first



projects of this association was the publication of a scientific journal. We have, therefore, given definite and concrete assistance to the research worker in this field by providing a medium for the publication of results. Our first editors labored under very severe handicaps, but their efforts have been rewarded. The development of "Cereal Chemistry" into a scientific publication of first rank is a real accomplishment and few realize the unselfish labor and loyalty which has been necessary for this attainment. Cereal Chemistry, today, from every standpoint ranks on a par with any scientific journal published.

### **Exchanging Ideas**

We may always profit by the exchange of ideas. In fact, it is often said that the trading of ideas is the only trade known in which both parties always profit by the exchange. This association has always encouraged the free interchange of ideas and experiences among its members. At these annual conventions chemists from flour mills, bakeries, allied industries, and state and federal laboratories have an opportunity to meet and exchange ideas and viewpoints concerning their several problems. Such discussions not only help to create a better feeling and understanding between the cereal industries, but are also responsible for a mutual respect and better feeling between chemists employed by competitors in the same industry.

The development of our local sections in more recent years has provided further opportunity for exchange of ideas and experience through open forum discussions of problems peculiar to certain districts. A membership in one of our local sections greatly benefits the individual chemist and the industry by which he is employed by keeping him informed of the latest developments in the field of cereal chemistry. The activity of our local sections has been responsible for a professional solidarity among cereal chemists, which has been greatly beneficial to the chemist.

### **Development of More Accurate Chemical Methods**

The development and improvement of analytical methods and technic for cereal products has always been a major objective of this association. The American Association of Cereal Chemists has continuously maintained a Committee on Methods of Analysis. Much of the improvement in methods and technic for analysis of cereal products during the last decade has been due to the efforts and constructive criticisms emanating from this organization. Fourteen years ago the cereal chemist was using methods for such routine determinations as protein and ash which had been developed primarily for the proximate analysis of feeding stuffs. These methods were satisfactory for feeding stuffs but were not sufficiently accurate for the use of the mill and bakery chemist.

The agricultural chemist fourteen years ago was well satisfied if his ash results were accurate to 0.05% and a variation of 0.05% between protein determinations was considered as accurate. It has been necessary to refine and improve old methods and in some cases devise entirely new procedures in order that greater accuracy might be obtained. Today that cereal chemist commonly reports ash in flour to a hundredth of a per cent, and protein in wheat and flour to a tenth of a per cent.



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This association has fostered and encouraged the introduction and adoption of uniform procedures for routine chemical work. Largely as a result of the work of local sections in sending out regular check samples it is now possible for different laboratories to agree very closely in their reports. Routine chemical work in our cereal laboratories has today reached a degree of accuracy which would have been regarded as utterly impossible a decade ago. The chemist's report is no longer a joke sheet, but is a respected document.

The improvement in accuracy by our cereal laboratories, however, has been a gradual and continuous process, and I doubt if even the chemist fully realizes the extent of the progress made. Signal progress has been made within the last five years, but before one could really properly appreciate what has been accomplished it would be necessary that he be transported quite suddenly back to the chaotic conditions of fourteen years ago.

The cereal chemist today, however, is still striving to secure greater accuracy in laboratory reports. During the last year the Committee on Methods of Analysis has made a critical study of the protein determination, to determine the causes of variations that now exist, and to establish definite limits of tolerance between reports of different laboratories.

We have accomplished much in the field of analytical methods and laboratory procedure, but much remains to be done. So far, it has been necessary to put more emphasis upon the improvement of routine procedures than upon development of new methods. During the next few years we should place more emphasis on the development of new procedures and chemical methods for determination of flour quality.

#### **Standardization of Baking Test**

Five years ago at the Minneapolis convention, the association authorized the appointment of a Committee on Standardization of Laboratory Baking. This committee faced what many regarded as an impossible task. It was a difficult undertaking, and the progress made during the first two years was relatively small. During the last three years, however, real and substantial progress has been made and it now seems possible that the goal may ultimately be reached. This committee's work has made it necessary for us both to learn and unlearn some things about baking tests. The baking committee had to take into consideration the changing conditions and consequent changing demand in the milling and baking industries of today, and is making contributions of both scientific and practical value to the milling and baking industries. The work of the baking committee has brought out many new facts regarding the bread-making capacity of different types of flour. While we may not yet be able fully to agree regarding the value and merit of recommended procedures, I feel that everyone must agree that marked progress has been made.

#### **Development of Methods for Testing Cake and Biscuit Flours**

Two years ago, at Omaha, the association authorized the appointment of the Committee on Methods of Testing Cake and Biscuit Flours. Until this committee was appointed our association had sadly neglected this important field. This committee, however, has achieved much in the two years of its existence. The Committee on Methods of Testing Cake and Biscuit

Flours, working in a pioneer field, has already made a valuable contribution to the soft-wheat-flour industries and this work should be continued and expanded.

### Study of Flour Specifications

At the 1928 convention, at Minneapolis, the association authorized the appointment of the Committee on Flour Specifications. This committee has made a real contribution in this first year's work, but the field is large and this year's work is only a beginning for still greater achievement.

The work of the Committee on Flour Specifications during the last year has been confined largely to a study of specifications on flour acidity and the relation of such specifications to actual flour quality. The committee in the future may render exceptional service to our cereal industries by studying present market specifications for cereal products and determining their relative value and merit. The findings of this committee would be regarded as unbiased and authoritative, and would eliminate, therefore, much of the controversy and argument over flour specifications, which prevail at present.

We have other committees which are rendering valuable and necessary services to the association. I have made particular mention of these four committees because they may properly be considered our service committees. These committees render a real service to the association, and through the association to the cereal industries. The work of these committees should be continued and expanded. As the work increases it may become necessary to divide the work of these committees and appoint new committees for specific tasks.

### Outlook for the Future

I have indicated briefly some of the accomplishments of our association. What of the future? Chemists in the cereal industries well realize that our fund of knowledge of the chemistry of cereals has been vastly increased during the last fourteen years. In spite of the achievements of the last few years, cereal chemistry, however, may still be regarded as a pioneer branch of chemistry. We have during the past fourteen years merely cleared away the rubbish of the old ideas and pet theories and now we are engaged in laying a firm and lasting foundation for a science of wheat and flour chemistry.

Today we find in our laboratories very competent cereal chemists. Chemists who not only have a thoro training in the fundamentals of chemistry, but who also have in addition a rich background of practical experience. Fourteen years ago the chemists in our cereal laboratories did not have this background of experience. The young cereal chemist of today may attain this necessary background of experience with much less effort and hardship than the pioneer of fourteen years ago. The chemist entering the cereal laboratories today has the advantage of the advice and counsel of chemists of experience, and in addition the use of an ever growing literature on the subject of cereal chemistry.

I doubt if we today properly appreciate the value of experience to the cereal chemist. Much of the information which a cereal chemist must have is unfortunately not found in textbooks. Much of the criticism of chemists and cereal laboratories has been due to the fact that business men have spent good money to establish laboratories in their plants and then unwittingly, in order to save a few dollars in salary, have employed an inexperienced chemist to take charge of the laboratory.

Considering the present background of practical experience, which hardly existed fourteen years ago, and the number of well trained chemists now in the cereal industries, it is reasonable to expect a larger measure of progress in the future than we have had in the past. No really worth-while objective, however, is ever attained without a real struggle and effort. The accomplishments of the past have been due to the unselfish efforts of men and women who have given freely of their time and energies for the common good. Our accomplishments in the future will depend on the extent to which we may be able to secure the same unselfish service in the solution of problems that may arise.

It is customary for the retiring president to make recommendations. My recommendations are embodied in this address and may well be summed up in two short words: "Carry on."

## **LOAF VOLUME AS PRODUCED BY DIFFERENT FLOURS UNDER PROLONGED FERMENTATION**

ROWLAND J. CLARK

Schulze Baking Company, Kansas City, Mo.

(Read at the Convention, May, 1929)

### **Introduction**

The author has been much interested during the last few years in the development of a standard baking test suitable for adoption by the American Association of Cereal Chemists. In experimenting with the "Standard Experimental Baking Test" described by Blish in *Cereal Chemistry*, vol. 5, page 158 (March, 1928), doughs were fermented in many instances over prolonged periods of time. Certain characteristics appeared in the resulting bread which may, after more intensive research, throw some light upon the quality and properties of the flours used. The characteristics noted are not restricted to the flours used in the work to be described. The same characteristics have been observed many times when flours were obtained from various sources. In some flours the characteristics are much more pronounced than in others.

It has been the belief of the author for several years that in baking a flour only a snapshot of its baking ability was obtained. This snapshot was usually taken at one point only. The picture was accurate only for the point in question. If the flour happened to be placed under slightly different conditions, instead of taking a new snapshot the operator "guessed" that certain results would be obtained. Frequently no new snapshots were taken. In short, the judgment of the operator was relied upon to "imagine" what the flour would have produced under the changed conditions. Natu-



rally the experience of the operator entered into his interpretations of the results obtained, when his snapshot had been taken at one point under certain fixed and rigid conditions; and, to this extent, his report was tinted with a personal factor. The operator thus used his imagination and judgment, not his labor and eyesight, to picture the possibilities of the flour. In numerous instances the judgment of the operator governed the treatment of the dough previous to baking, and it was frequently thought that in this way the best baking ability of the flour was reached. The resulting loaf of bread was considered the best that could be baked from the flour in question and upon this inaccurate information shipments of flour were accepted or rejected. The operator did not know absolutely whether the flour's maximum baking ability had been reached.

To eliminate part of the operator's judgment, it was thought that if numerous snapshots of the flour's baking ability were taken at different points and these pictures pieced together into a continuous reel, much of the guess work could be turned into accurate information. It is extremely difficult to predict the action of nature, as some of the weather forecasts demonstrate, but history can record accurately the weather of yesterday or how a flour reacted under the desired conditions. Therefore, to obtain this continuous picture of a flour's baking ability many loaves were baked, varying the mixing time, the fermenting time, and the absorption. As the baking method used differs in many respects from that described by Blish in the article cited above, a description of the procedure is given below.

### Materials

The flours used for this experiment were a 2½% low-grade flour, an 83% cut straight (in which the short patent mill stream had been divided and part of it packed off separately), and an 85% short patent flour. All these grades were made the same day by a 1000-barrel capacity commercial mill on a milling yield of 4 bushels 36 pounds, based upon elevator wheat. The wheat averaged 60 pounds per bushel, was tempered 24 hours, and was obtained from southwestern Kansas in the crop year of 1926.

### Formula

Flour . . . . .	500 grams on 15% moisture basis
Yeast . . . . .	15 grams
Salt . . . . .	5 grams
Sugar . . . . .	12.5 grams
Water . . . . .	(distilled) to make dough the right consistency as judged by preliminary baking.



### Procedure

**Mixing.**—The salt, sugar, and yeast were dissolved in a small portion of the water and added immediately to the mixing bowl of a small Hobart bread-mixing machine. The rest of the absorption water, previously determined by preliminary baking, was added to the bowl and thoroly stirred into the yeast solution before the flour was added. After adding the flour, mixing was started with the machine on the lowest speed, using the question-mark-shaped mixing arm of the machine's equipment. As soon as the arm picked up the dough, the machine was thrown into high speed (215 r.p.m.) and the dough was mixed the number of minutes that had been shown by preliminary baking to produce the best results. The temperature of the ingredients was so regulated that the doughs came from the mixer at 86 degrees F. (30 degrees C.).

**Fermentation.**—As soon as the dough came from the mixer, it was scaled into 165-gram portions, each of which was placed in a small fermentation bowl and set in an automatic temperature and humidity (79%) controlled proof cabinet held at 86°F. (30°C.) for fermentation. The time of fermentation was varied by certain time intervals (as shown in the data presented) starting at about 30 minutes and continuing to about 5 hours, each dough being fermented for a different period. Enough large doughs were mixed to produce loaves of varying fermenting periods. Each dough was punched (once only) 15 minutes before panning, as described by Blish under "Fermentation" for the first punch.

**Molding and panning.**—Molding and panning were carried out exactly as described by Blish in the article mentioned earlier in this writing.

**Proof.**—The doughs were each proofed exactly 55 minutes under the same conditions as for fermentation.

**Baking.**—The bread was baked at a temperature of 475°F. for 25 minutes; loaf volume was measured by seed displacement immediately upon removal from the oven.

### Equipment

**Mixer.**—A Hobart mixer model 10 equipped with a 3-quart mixing bowl and a question-mark-shaped mixer arm were used for mixing.

**Fermentation bowls.**—The fermentation bowls were the same as described by Blish—top diameter 5 inches, bottom diameter 2 inches and depth  $2\frac{1}{4}$  inches.

**Baking pan dimensions.**—The pan dimensions were the same as described by Blish—bottom inside 53x93 mm.; height sides 85 mm., ends 69 mm., top inside (at height of 68 mm.) 60x105 mm. the pans were made of tin.

### Data

The data recorded upon baking the three grades of flour mentioned under "Materials" together with analyses of the flours are given below.

Flour	Low grade	85% Patent	Cut straight
Moisture %	11.01	12.61	12.90
Protein (Nx5.7) %	12.88	10.81	11.24
Ash %	0.763	0.371	0.400

The protein and ash figures were calculated to a moisture basis of 13.5%.

### BAKING DATA

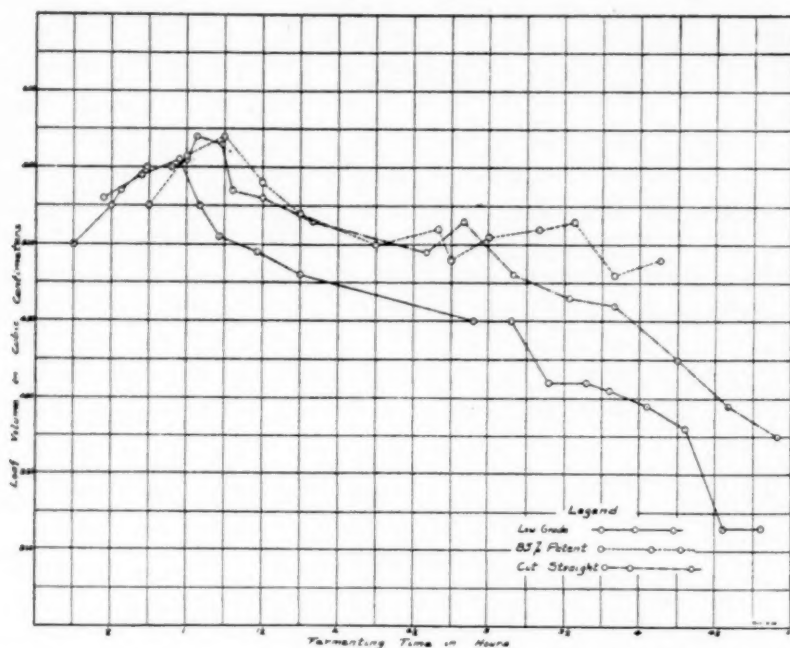
Loaf No.	Low Grade		85% Patent			Cut Straight		
	fermenting time		fermenting time		Volume	fermenting time		Volume
	hr.	min.	hr.	min.		hr.	min.	
1	..	27	..	45	525	..	15	500
2	..	42	1	..	565	..	30	525
3	..	57	1	15	570	..	34	535
4	1	5	1	30	540	..	44	550
5	1	13	1	45	520	..	54	550
6	1	28	2	15	500	1	..	555
7	1	45	2	40	510	1	4	570
8	2	54	2	45	480	1	14	565
9	3	9	3	..	505	1	18	535
10	3	24	3	20	510	1	30	530
11	3	39	3	34	515	1	50	515
12	3	48	3	50	480	2	35	495
13	4	3	4	8	490	2	50	515
14	4	18	..	..	..	3	10	480
15	4	33	..	..	..	3	32	465
16	4	48	..	..	..	3	50	460
17	..	..	..	..	..	4	15	425
18	..	..	..	..	..	4	35	395
19	..	..	..	..	..	4	55	375

### Discussion

If the baking data for each flour are plotted in a curve, using the fermenting periods for the abscissas and loaf volumes for the ordinates, certain characteristics of the flour will be noted that are important from a baking standpoint.

The low-grade curve reaches a peak in volume on loaf 3. This loaf represents the maximum baking ability of this flour. It had the combination of good grain, texture, crust color, and shred with the largest volume obtained. At no other point throughout the fermentation curve was this combination secured. Loaves No. 2 and No. 4 did not have so well balanced a combination of properties. The peak on this flour

was sharp, as only one loaf contained all the desirable qualities. Loaves Nos. 5, 6, 7, and 8 were not very good in general characteristics, but loaf No. 9 was much better in grain, texture, and shred than any loaf after No. 4. Loaves Nos. 10, 11, and 12 resembled Nos. 5, 6, 7, and 8 in having poor characteristics; No. 13 resembled No. 9 in a few properties. Other properties, as crust color and size, were different. Summing up the points concerning the low-grade bakings, loaf No. 3 constituted the maximum baking ability of the flour, thereby showing that the flour had to be handled very carefully to produce best results. Loaves Nos. 9 and 13 constituted minor peaks, with No. 13 having more undesirable properties than No. 9. The loaves occurring before and between Nos. 3, 9, and 13 were very poor. In short, loaves Nos. 3, 9, and 13 stand out as what might be called peaks of the flour's baking ability, arranged in descending order of importance.



Curves Showing Loaf Volumes Produced by Baking a Low Grade, an 85% Patent, and a Cut Straight at Different Fermenting Periods

The 85% patent curve reaches its first peak in loaf No. 3; but loaves Nos. 2 and 4 were little different in grain, texture, shred, and crust color. Especially was this true of loaf No. 2. It is therefore concluded that fermenting times anywhere between those of loaves Nos. 2 and 4 would produce good bread and that the peak of this

flour was much broader than that of the low grade. The minor peaks occurred in loaves Nos. 7 and 11; the intermediate loaves were not nearly so good in grain, texture, shred, and crust color.

The cut straight curve reaches its first and most important peak in loaf No. 7 but loaves Nos. 4, 5, 6, 8, and 9 were very good in grain, texture, shred, and crust color; therefore this flour is considered capable of making good bread over a range of 34 minutes, based upon the procedure used. Only one minor peak was found in the cut straight, loaf No. 13. Perhaps the fermentation was not carried far enough to locate another peak, or the peak may have been so faint that it could not be detected among the other loaves.

It is interesting to note that the range over which the low-grade flour produced good bread was very small (at most, only five minutes), as one loaf stood out as best. The 85% short patent produced good bread over a range of about 30 minutes and the cut straight over a range of at least 34 minutes.

It is believed that in the minor peaks pointed out above lies the explanation of much of the misunderstanding between chemists on flour quality and between millers and bakers on accepted or rejected flour shipments. If one person baked on the first peak, he called the flour good; if another baked on a minor peak, he might agree that the flour was good but not up to what the first person found; while, if a third person baked at a time intermediate between the first peak and a minor peak (in other words in a valley between peaks) he would condemn the flour. Each of these workers would be correct and truthful in his opinions, but each would have taken a snapshot and not a moving picture of the baking ability of the flours.

As to what causes the major and minor peaks pointed out above, the author has formulated a theory. Lack of time has prevented sufficient research to prove or disprove this theory. The reason that appears most plausible is that the major peak is brought about by the proper conditioning of the flour proteins. As the fermentation proceeds, the ordinary phosphate salts, composing the ash of the flour, are changed first to the mono-acid salts and then to the di-acid salts. The points at which these transformations take place produce the minor peaks through the action on the protein of the salts formed.

### Summary

1. By baking a flour into loaves of bread (each with a different fermenting period and spaced at short time intervals apart) some loaves appear to have superior qualities in grain, texture, crust color, break, and shred as well as larger volume.

2. The results obtained by baking three flours, a low-grade, an 85% patent, and a cut straight, are given in detail.

3. If the baking data for each flour are plotted in a curve, using the fermenting times for the abscissas and loaf volumes for the ordinates, the curve exhibits a major peak and sometimes one or more minor peaks.

4. It is believed that by means of such a curve information can be obtained concerning the baking qualities of a flour far more accurately than by baking a single loaf of bread.

5. It is believed that the major peak may represent the maximum baking ability of the flour and occurs when the proteins are properly conditioned. The minor peaks may be the points at which the tri-valent phosphate salts pass first into the mono-acid and then the di-acid salts with their consequent effect on the flour proteins.

## A RUGGED TYPE OF CALOMEL ELECTRODE VESSEL

L. V. SORG

The Larabee Flour Mills Company, Kansas City, Mo.

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Many electrode vessels are available for the preparation of calomel half cells and each has its particular merits. It is natural that each chemist may find one more suited to his particular needs than another. Of prime importance, however, is a construction that is simple and rugged yet capable of maintaining the accuracy of the cell. It is hoped that such are the merits of the cell to be described.

Several important considerations are covered in this design. First, nothing should be permitted to affect the accuracy and constancy of the cell. One factor is to prevent the diffusion of any solutions into the cell. Clark states that capillaries should be avoided, as these disturb the liquid junction and permit contamination of the cell. Koltoff, also, states that the diffusion of potassium chloride into solutions containing certain proteins causes errors, owing to the interaction of these with the potassium chloride. Second, there must be a means of reproducing a new liquid junction at frequent intervals. The renewal of the liquid junction serves to minimize the contact potential set up here.

The constructional detail of the vessel can be readily seen from the drawing and photograph. One of the chief merits of this vessel is that any one, with only a little practice at glass blowing, can construct

it easily. The cost is negligible. The vessel consists of two sections of pyrex tubing. The larger one (9.5x2.2 cm.) is drawn to approximately the diameter of the small tubing (5 mm.). This piece of tubing is 14 cm. in length. Half of this is sealed into the larger tube, the other half remaining outside. The outside end of the small tubing

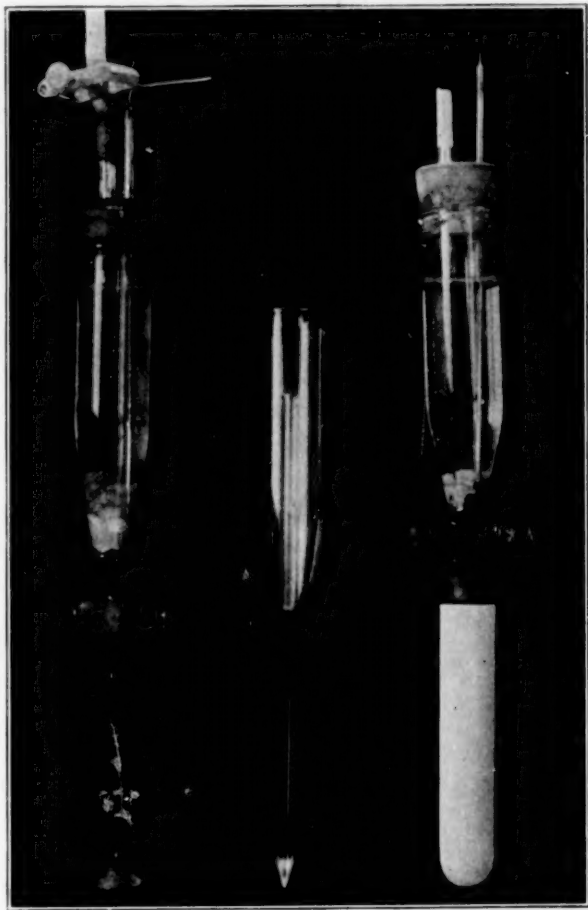


Fig. 1. Three Types of Electrode Vessels

is drawn to a tip. In the construction of this tip lie the good qualities of the vessel, if it is to be used without the diffusion cup, which will be described later. The tip should be drawn abruptly but not to a fine capillary thread. While the opening should be small, capillaries must be avoided. It is best to draw out the tube to an opening larger than desired and then fire-polish it until the correct size is obtained. The seal between the two tubes can be made in two ways. Either a



small bulb may be blown into the small tube at the point of the seal and then the seal made to this or the larger tube fitted closely about the smaller and then sealed with De Kotinsky's hard cement.

As a further prevention against contamination and diffusion, a one mm. bore, ungreased stopcock can be used in the smaller tube just below the point of the seal. If this is used, great care must be exercised in making the seal to avoid breaking the stopcock by unequal heating. The stopcock is kept closed except when flushing the cell. It has a tendency to "freeze" but is easily opened by washing with water.

Also a diffusion cup may be placed over the protruding tube, which offers a liquid junction yet largely prevents diffusion. This cup is merely an unglazed porcelain filter cone with the flange cut off.

An ideal combination would be the use of the ungreased stopcock with the diffusion cup. With this combination, the cell need be flushed only at the beginning of each day's work, while it will suffice to wash the diffusion cup between each two determinations.

Contact with the mercury of the calomel cell is made by a platinum wire inserted through a rubber stopper, which is the top of the cell. A connection to a reserve supply of potassium chloride may be made here.

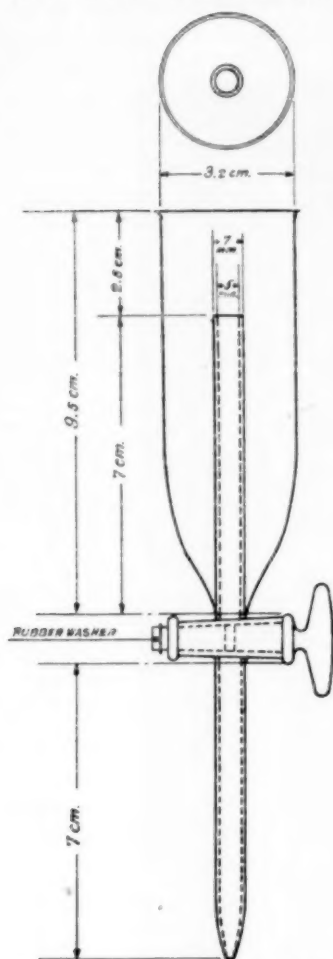


Fig. 2. Constructional Diagram of Electrode Vessels

### Correction

In the paper entitled "A Quick Viscosimetric Method for Measuring the Staleness of Bread," by L. P. Karacsonyi, appearing in the May, 1929 issue, the footnote under Table I, which reads "T is the measured relative viscosity of the suspension," etc. should read "T is the time of flow of the suspension."

## THE DETERMINATION OF CAROTIN IN FLOUR<sup>1</sup>

CHARLES G. FERRARI AND C. H. BAILEY

Division of Agricultural Biochemistry,  
Agricultural Experiment Station, St. Paul, Minn.

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### Development of a Method for the Determination of Carotin in Flour

In the colorimetric determination of the gasoline color value of flour by the A. O. A. C. tentative method, the procedure is to add 100 cc. gasoline to 20 grams of flour, shake vigorously for five minutes, shake again after standing for 16 hours, and then filter immediately through filter paper, taking precautions to prevent evaporation. This method of preparing the flour extract for spectrophotometric examination was tried and found unsatisfactory, as it was never possible thus to prepare an extract entirely free from suspended particles. Preparations that appeared visually clear frequently gave inconsistent results with the spectrophotometer. The effect was always to give a much lower transmittancy than was obtained with solutions whose clarity was less doubtful. The spectrophotometer is capable of discerning small differences in the transmittancies of solutions, and the scattering of light by suspended particles of flour was no doubt responsible for the difficulty encountered. Various grades of filter paper were used with the same result. The use of several thicknesses of filter paper is open to question, even if successful in clarifying the solution, because carotin is adsorbed by the paper. This adsorption was demonstrated markedly when paper pulp was used as a filtering medium. Siphoning the supernatant liquid without disturbing the flour was attempted, but this procedure was not always successful. Centrifuging alone was also unsatisfactory.

An unglazed porcelain filter was used to clarify a petroleum ether extract of flour, but while it was eminently satisfactory in clarifying the solution, it removed by adsorption considerable amounts of carotin. A petroleum ether extract of an unbleached flour sample, which yielded a solution with a dark yellow hue, became colorless on filtration through the unglazed porcelain filter.

<sup>1</sup> Published with the approval of the Director as Paper No. 875, Journal Series, Minn. Agr. Expt. Sta. Condensed from one section of a thesis presented by C. G. Ferrari to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Alundum thimbles were tried. Some alundum thimbles yielded unsatisfactory results because the extract filtered through them was visibly turbid. When an alundum thimble having the required fineness of porosity was used the special procedure outlined below was found necessary.

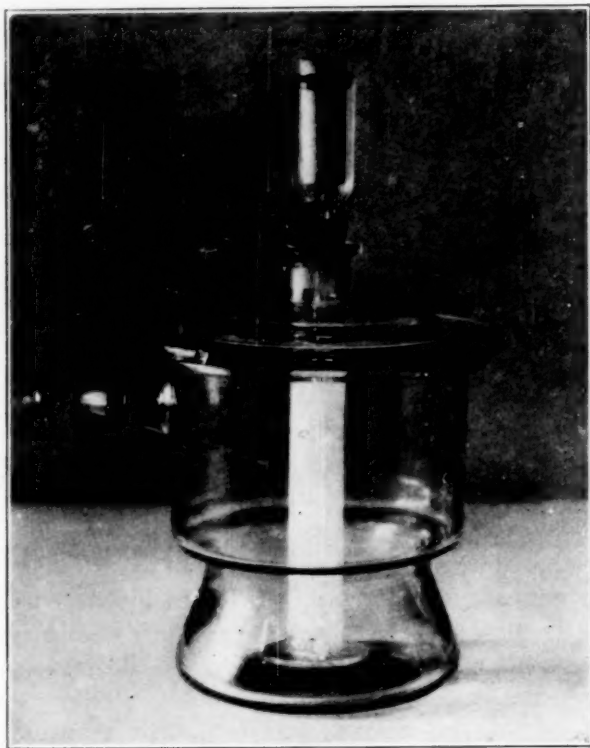


Fig. 2. Apparatus for Filtering Petroleum Ether Extracts of Flour Through Alundum Thimble

**Alundum filtration procedure.**—The detailed procedure for the preparation of a flour extract for spectrophotometric examination was as follows: The sample, usually 20 grams, was weighed into a glass-stoppered bottle and 100 cc. of petroleum ether was added by pipette. The bottle was agitated at frequent intervals to secure thoro mixing and then was placed in a dark drawer or cupboard over night. The supernatant liquid was siphoned off into a suitable vessel. The apparatus used for filtering this solution through an alundum thimble is illustrated in Figure 2. It consisted of a vacuum desiccator arranged with an adapter funnel at the top. This funnel carried the alundum thimble, which was seated in place by means of a rubber washer. Beneath the funnel a 50-cc. graduated cylinder was placed

for catching the filtrate. Some petroleum ether was poured into the bottom of the desiccator to furnish a saturated atmosphere of the solvent.

The thimble was first thoroly wet with some of the solution to be filtered, and for this purpose the solution was allowed to stand in contact with the thimble for several minutes, during which time it gradually seeped through. Another purpose was to permit the alundum to adsorb carotin from the solution and reach an equilibrium with it. Then very gentle suction was applied until the liquid dropped rapidly through the funnel, but did not run in a steady stream. After several washings with small portions of the siphoned flour extract the graduate was placed under the funnel and 50 cc. was poured slowly into the thimble, taking care not to fill the thimble over a depth of about a quarter inch. The purpose of the graduate was to observe the volume of filtrate obtained. If the operation was carried out carefully as outlined, the amount of solvent lost by evaporation was negligible. It seldom happened that after three consecutive filtrations of the same material less than 49 cc. of the original 50 cc. was recovered.

In order to determine the effect of alundum filtration on the transmittancy of petroleum ether solutions, the material was filtered through the thimble several times and the transmittancy was determined after each filtration. Some representative results are recorded in Table IV.

With Nos. 1, 2, 3, 6, and 7, the transmittancies dropped upon the second filtration. If adsorption had taken place an increase in the transmittancy would have been expected. On the other hand, if evaporation had taken place the pigment would be concentrated and the transmittancy would decrease as noted. This does not appear to be the explanation, however, as a third filtration through alundum resulted in four cases in an increased transmittancy, and in the other cases in very little change.

That changes of the same magnitude as observed on the second filtration did not recur on further filtration was shown in Nos. 1 and 2, which were filtered the fourth and fifth time without appreciable change in transmittancy. No. 3 appeared irregular in that the transmittancy rose to a higher value when the thimble employed in the first three filtrations was replaced by that used in filtering Nos. 1 and 2. The low transmittancy obtained with the first thimble was due to the fact that it did not retain all the flour particles, and these scattered light, reducing the transmittancy value. This effect was clearly dem-

onstrated when the original thimble was used once more to filter the same solution, because the lower value for the transmittancy was obtained again. The turbidity necessary to cause variations in the transmittancy value is very slight, and frequently escapes the eye.

TABLE IV  
EFFECT OF ALUNDUM FILTRATION ON TRANSMITTANCY OF PETROLEUM ETHER EXTRACTS OF FLOUR  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

Treatment	1	2	3	4	5	6	7
	Sample No. 393					Sample No. 400	
	Per cent transmittancy						
Filtered once through alundum thimble	20.0	20.9	17.6	13.4	19.6	11.5	11.5
Readings repeated	19.3	.....	17.3	.....	.....	.....	.....
Readings repeated	19.4	.....	.....	.....	.....	.....	.....
Filtered second time through alundum	16.6	18.4	15.5	19.7	20.4	10.9	11.2
Readings repeated	16.6	.....	15.5	.....	.....	.....	.....
Filtered third time through alundum	19.2	20.1	15.3	20.7	20.2	11.4	10.9
Readings repeated	19.8	20.3	15.3	.....	.....	.....	.....
Filtered fourth time through alundum	19.3	20.1	.....	.....	.....	.....	.....
Filtered fifth time through alundum	.....	20.0	.....	.....	.....	.....	.....
Filtered through different thimble	.....	.....	19.8*	21.0	18.0	.....	.....
Filtered again through above thimble	.....	.....	19.7*	20.6	18.1	.....	.....
Filtered through original thimble	.....	.....	15.8	.....	.....	.....	.....
Readings repeated	.....	.....	16.2	.....	.....	.....	.....

\*Same thimble used as in Nos. 1 and 2.

Whatever the explanation of the fall in transmittancy after the second filtration, it appeared safer to filter petroleum ether extracts of flour through alundum at least three times to secure a constant value. This procedure was adopted where alundum filtration was resorted to.

**Capillary siphon procedure.**—The petroleum ether extract of flour was prepared as described under the alundum filtration procedure. In order to secure a perfectly clear supernatant liquid it was found necessary to allow the flour and petroleum ether to stand undisturbed for at least 24 hours. In some cases a longer time was found necessary, but never more than 48 hours. A noticeable bleaching effect can be observed visually when such extracts are stored in the light on the laboratory shelf for several days. Schertz (1925a) has shown that a petroleum ether solution of pure carotin is stable when kept in an ice chest, and shows no appreciable diminution in concentration after about

150 days. The samples used here were always stored in the dark, but not on ice. It appeared improbable that the transmittancy of the flour extract would change significantly when stored in the dark for as short a time as 24 to 48 hours.

The siphon tube was made from glass tubing approximately 2.5 mm. inside diameter, and both ends of the siphon tube were drawn out to a capillary of 1 mm. diameter or less. The difference in the level of the two ends was approximately 5 cm. The siphon tube was inserted in a stopper that fitted the glass bottle containing the sample and the supernatant petroleum ether. The stopper was provided with another tube to allow starting the siphon. When the siphon tube was lowered into the supernatant petroleum ether solution, care was exercised to keep it about 3 cm. above the settled flour in order not to disturb it during the siphoning process. An additional precaution is to have the end of the siphon tube that is inserted into the extract bent in the form of a letter U. The settled flour is then still less likely to be disturbed by the siphoning liquid.

After inserting the siphon tube carefully into the supernatant petroleum ether solution, siphoning was begun by gently blowing with a steady, continuous pressure until the siphon began to operate. Should the flour be stirred up by reason of clumsy manipulation, the solution obtained can not be used directly in transmittancy measurements, but must be handled as described under alundum filtration. No difficulty was experienced in securing a perfectly clear filtrate by siphoning, but if the flour should be accidentally agitated, alundum filtration must be resorted to or a fresh sample prepared.

The petroleum ether extract siphoned very slowly under the above conditions, and it was possible to catch the liquid directly in the cell in which the transmittancy measurements were made, rinsing it several times before filling.

It might appear that the alundum filtration procedure was no longer useful, as the capillary siphon method was more rapid and afforded similar results. This is not the case, however, as it often is desirable to make observations more rapidly than is possible with the siphon method, which necessitates that the sample stand for a comparatively long time. Further, some samples are much more difficult than others to prepare free from turbidity, in which case the alundum filtration procedure is preferable.

**Comparison of methods for preparing flour extract.**—Some of the results obtained with the various procedures for preparing the flour extract are outlined in Table V. The data show the inconsistencies of



the results obtained with filter paper. Thus, sample No. 393A showed a variation of 100 per cent, and large differences were obtained with other samples filtered through paper.

TABLE V  
EFFECT OF TYPE OF FILTRATION ON TRANSMITTANCY OF A PETROLEUM ETHER EXTRACT OF FLOUR  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ )

Method of filtering sam. 1.	Sample No.								
	1	9951	393A	393B	393B2	393C	100	400A	400B
	16.3	37.7	15.5	18.5	48.0	.....	.....	9.5	.....
Filter paper	.....	.....	7.6	16.4	41.4	.....	.....	.....	.....
filtration	.....	.....	.....	15.9	.....	.....	.....	.....	.....
Ordinary siphon	19.7	43.8	19.5	.....	.....	.....	.....	.....	.....
Alundum thimble	21.5	47.6	19.9	18.4	61.3	18.0	10.9	11.5	12.8
filtration	.....	.....	.....	18.6	62.0	18.6	11.4	11.5	13.4
	.....	.....	.....	.....	.....	.....	11.3	.....	13.3
Paper pulp	.....	61.6	.....	.....	.....	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	11.9	13.4
Capillary siphon	.....	.....	.....	.....	.....	.....	.....	12.1	13.4
	.....	.....	.....	.....	.....	.....	.....	.....	13.5

The ordinary siphon tube as contrasted with the capillary siphon, is not recommended; it is never possible to know with certainty that the settled flour is undisturbed. In many instances not reported in the table, a distinct turbidity was observed after ordinary siphoning, and the data thus secured were obviously incorrect. Many samples, which on casual observation appeared clear to the eye, gave results that were known to be incorrect, and on close inspection a scarcely discernible turbidity was detected. The transmittancy of such solutions increased in value when the cell in which the observations were made remained undisturbed until settling had taken place.

The adsorption of carotin by paper pulp was manifest in the considerably higher value for the per cent transmittancy secured in its use. The alundum filtration procedure (which is considered reliable) yielded a transmittancy of 47.6 per cent in sample No. 9951; the paper pulp used in filtering the same sample gave a value of 61.6 per cent. Paper pulp was totally unsatisfactory as a filtering medium in the form used.

An inspection of the data in Table V shows that the transmittancies secured by the method of alundum filtration agreed very well upon duplication with different lots of the same sample. Results secured by the capillary siphon method were comparable to those secured by alundum filtration. For example, sample No. 400 gave a transmittancy of 11.9 and 12.1 per cent by the capillary siphon method. These solutions were then filtered through alundum as previously described, to determine whether or not the per cent transmittancy would increase

by the removal of suspended particles. Each solution gave a value of 11.5 per cent transmittancy. This demonstrated that either method could be used satisfactorily, since the results secured by the two methods checked within reasonable limits. The data support the contention that the alundum filtration method as outlined did not give incorrect values due to adsorption phenomena, as the method of capillary siphoning with which it checked did not permit of adsorption. Further, if the alundum adsorbed carotin from solution and the liquid obtained from capillary siphoning contained flour particles, the first method would yield transmittancy values that were too high, and the second, values that were too low. Thus the errors in the respective measurements would tend in opposite directions, and the fact that both methods gave satisfactory check results indicated that either was satisfactory. The capillary siphon method has the theoretical advantage of eliminating the possibility of adsorption by a filtering medium, and the additional advantage over the alundum filtration procedure of reducing the possibility of the evaporation of the solvent.

Coleman and Christie (1926) reported a rapid method for the determination of the gasoline color value of flour in which they employed a mechanical stirrer for agitating the flour sample with gasoline. The vigorous stirring eliminated the necessity of waiting 16 to 24 hours before making the colorimetric observations. A special stirrer of this type was not available in these studies, but there appears to be no reason why the preparation of the sample for spectrophotometric observation could not be carried out in the same manner. After stirring, the material might properly be centrifuged, after which the supernatant liquid could be removed with a capillary siphon; or else the alundum filtration procedure could be employed.

**Some general considerations in preparing the extract of the sample.**—In the determination of the gasoline color value of flour by the regular colorimetric procedure, gasoline is employed as the solvent and not petroleum ether. In order to ascertain whether or not the use of gasoline in the spectrophotometric procedure yielded results different from those obtained with petroleum ether the two solvents were compared. *A priori*, no difference in the per cent transmittancy was expected, because in the method of measuring transmittancy the reference cell contains the solvent alone and thus a correction for the absorption of light by the solvent is automatically made.

This reasoning was substantiated by the results of the comparisons that were made, the transmittancy values obtained with the two solvents being in all cases in harmony. The gasoline employed was high

test, and colorless. It is not intended to argue that any gasoline, whether colorless or not, would be satisfactory, but on the other hand it is recommended that a good grade of colorless gasoline be employed as a desirable precaution. In view of the fact that high test gasoline was found satisfactory for transmittancy measurements, it was employed generally as the solvent in these studies. It had the advantage over petroleum ether of being much less expensive and less volatile. The terms "petroleum ether" and "gasoline," as used hereafter may thus be considered identical for the purpose of extracting flour for transmittancy measurements.

It was customary in these studies to use 20 grams of sample with 100 cc. of petroleum ether, determining the transmittancy in a 10-cm. cell at wave length 435.8 m $\mu$ . This ratio of sample to solvent was found most convenient, as the transmittancies of most samples examined could then be read in a cell of the same length. The petroleum ether extract of the ordinary flour sample under these conditions gave a transmittancy of less than 25 per cent. By lowering the photometer sectors in the manner provided, the accuracy of the settings in this range was greatly increased; the transmittancy was quadrupled and the readings obtained were divided by four. With bleached flour samples the instrument was used with the photometer sectors in their normal position, and the transmittancies ranged normally between 25 and 60 per cent. In special cases where a sample gave an extract the transmittancy of which was too low for accurate observation, for example, on the order of 2 per cent, a different ratio of sample to solvent was deemed advisable.

The obvious advantage of using the procedure outlined for all flour samples was that it became possible directly to compare their transmittancies without the necessity for making laborious calculations. For the reasons stated, the ratio of sample to solvent was always 20 grams to 100 cc. unless otherwise noted.

**Precautions to observe in making transmittancy measurements.**

--In making spectrophotometric measurements some factors that appear trivial in themselves may operate to give readings that are far from correct. Some of the precautions it was found necessary to observe will be enumerated at this point.

In filling the cell with the extract of the sample or the solvent it proved desirable to handle the cells with a towel. Petroleum ether or high test gasoline is very volatile, and when handled with the fingers it became especially difficult to prevent the liquid from seeping out around the edges of the cover glasses at the ends of the cell because

of the warmth imparted to the cell by the hand. When the solvent crept out over the outside surface of the cover glasses an uneven film of material prevented accurate transmittancy measurements. Even if seepage was stopped, the glass remained smeared. It was found absolutely essential to have perfectly clean, polished glass surfaces before transmittancy measurements were made. To this end it was the practice not only to handle the cells with a towel but to clean the end glass plates with a clean cloth moistened in alcohol, after which a dry cloth was used for polishing. Failure to keep the cover glasses clean and polished resulted in transmittancies lower as much as 3 to 10 units.

After the cell was filled and the end plates were polished, it was necessary to scrutinize the cell carefully in an effort to detect the presence of suspended particles and turbidity. The light scattering due to suspended material introduced a very large error, and the error was appreciable—2 to 3 per cent lower, even with solutions that on first glance appeared satisfactory. The turbidity factor, when pronounced, gave transmittancy readings ranging from 20 to 70 per cent. When turbidity was suspected but was not sufficiently pronounced to be positively detected, the procedure was followed of setting the tube with its contents aside and allowing it to remain undisturbed for several hours. If the solution had been clear, a repetition of the readings at the end of this time yielded the same per cent transmittancy, but not infrequently higher transmittancy values resulted, owing to the settling of suspended material. The suspended material, if present, could then be easily discerned with the eye by rotating the tube rapidly while looking through it, whorls forming.

After taking the above precautions the cell was ready to be placed in the sample holder. It was allowed to remain in place several minutes before readings were taken, as handling sometimes imparted sufficient heat to set up convection currents that were easily seen with the naked eye. The readings secured while convection currents persisted were erratic.

The alignment of the holder that supported the cells was found to be an important adjustment.

A final precaution was taken of inspecting the tube after the measurements had been taken in order to insure that the end cover glasses had remained clean and bright during the measurements. If this were not the case, the ends were repolished and the readings repeated.

In reading the transmittancy the eyes were shaded by a black cloth thrown over the head. After a few preliminary settings of the

photometer scale the eye became accustomed to the illumination of the photometric field. The photometric field was matched by slowly oscillating the scale, making each half of the field alternately darker and lighter. The slow oscillation was reduced to a small scale interval and a match obtained by stopping at the mid point of an oscillation. Ten such readings were recorded in each case, and the average reported. After some practice it was possible to secure close checks between individual readings.

The mercury vapor arc lamp required careful attention. It was necessary to insure that the lamp equally illuminated the two halves of the photometric field. If a long series of measurements was made, the lamp required readjustment at the end of one or two hours, especially if a noticeable flicker developed. When a flicker developed in the light source it was readily eliminated by turning off the current and then starting the lamp again immediately. This necessitated oscillating the lamp and its original position was thus disturbed. Whenever the lamp was disturbed for any reason, the photometric fields were matched at 100 per cent transmittancy before measurements were made. The match of the photometric fields was checked again when the readings were completed.

#### **Effect of Changing the Ratio of Sample to Solvent on the Transmittancy of Gasoline Extracts of Flour and the Concentration of Carotin Determined**

In the studies reported it was the custom to use 20 grams of flour with 100 cc. of gasoline, conducting the transmittancy measurements in a 10-cm. cell at a wave length of 435.8 m $\mu$ . The reasons for this procedure have been discussed.

The ability of some substances to adsorb carotin from solution is well known. This phenomenon was encountered in devising a method for preparing the gasoline extract for spectrophotometric examination and has been discussed. In order to determine to what extent, if at all, flour itself adsorbed carotin from solution, gasoline extracts of a flour sample were prepared using 10, 15, 20, 25, and 30 grams of sample with 100 cc. of gasoline in each case. The transmittancy was then determined in the manner previously described, and the concentration of carotin calculated for each dilution. The results are recorded in Table VI.

The data show that adsorption of carotin by the flour is of significance in determining the absolute concentration of carotin in the flour. The amount of carotin extracted apparently depends upon the ratio of sample to solvent. The larger the sample used with the same



quantity of solvent the less carotin was extracted, or the more carotin was adsorbed from the solution.

The data are plotted in Figure 3, where the weight of the flour sample is plotted along the axis of ordinate, and the concentration of carotin along the axis of abscissa. When the data were plotted in the above manner it was evident that the relation between the two coordinates was a linear one between the limits of concentration used. The values obtained experimentally were integrated by the method of least squares, and on the assumption that the relation at greater dilution would continue to be a linear one, the curves were extrapolated to zero concentration of flour. It thus became possible to calculate from the integrated curves an approximate correction, which may be applied to the carotin concentration determined in the conventional manner to make it correspond more closely to the amount of carotin in the flour.

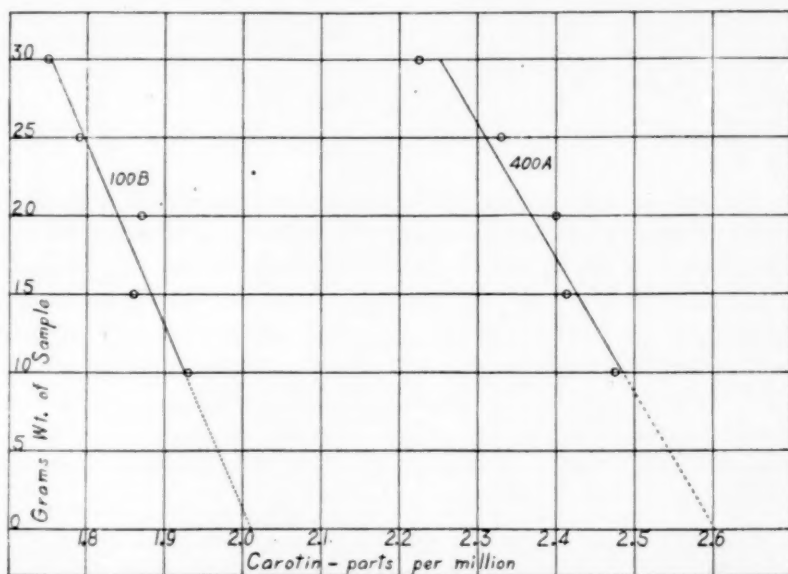


Fig. 3. Effect of Changing the Ratio of Sample to Solvent on the Concentration of Carotin in Flour Determined from Transmittancy Measurements of Gasoline Extracts

In the conventional method previously described, where 20 grams of flour are used with 100 cc. of petroleum ether, the correction factor was found to be approximately 10 per cent. That is, the concentration of carotin should be increased by at least 10 per cent of the determined amount in order to estimate more closely the absolute concentration of carotin in the flour.



TABLE VI  
EFFECT OF CHANGING THE RATIO OF SAMPLE TO SOLVENT ON THE TRANSMITTANCY OF GASOLINE  
EXTRACTS OF FLOUR AND THE CONCENTRATION OF CAROTIN THUS OBTAINED  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

Sample No. 100B				Sample No. 400A			
Wt. of flour	Per cent T	Carotin parts per million	Carotin parts per million integrated value	Wt. of flour	Per cent T	Carotin parts per million	Carotin parts per million integrated value
grams				grams			
10	42.6	1.93	1.926	10	33.5	2.47	
				10	33.3	2.48	2.485
15	29.0	1.86	1.883	15	19.8	2.44	
				15	20.2	2.40	
				15	20.1	2.40	2.427
20	19.2	1.87	1.840	20	12.1	2.39	
				20	11.9	2.41	2.369
25	13.8	1.79	1.797	25	7.5	2.34	
				25	7.7	2.32	2.310
30	9.7	1.75	1.754	30	5.1	2.24	
				30	5.3	2.21	2.252

Owing to the limited number of observations on which this estimate was based, the correction given can be considered an approximation only. By repeating the observation a greater number of times in the manner indicated, a more exact approximation can no doubt be made.

The calculation of this correction factor naturally brings up the question, why were repeated extractions not made and the concentration of the carotin in the combined extracts determined. Such a procedure is not satisfactory for several reasons. It was found experimentally that at least four and frequently more extractions are required to exhaust the sample of carotin. In the determination of the transmittancy of the resulting extract the dilution would be so great that the transmittancy reading would be very high. That is, the sample would transmit so much light that a satisfactory determination would be more difficult and less accurate. Nothing would be gained.

Evaporation of the solvent to increase the concentration would not be desirable, as the heat applied in effecting the evaporation might destroy some of the pigment, which is very sensitive to oxidation. The latter is likewise the reason why extraction of the sample for 16 hours in a continuous extractor of the type used in crude fat determinations would give questionable results.

The most serious difficulty to overcome in the determination of the transmittancy of a flour extract is the scattering of light by suspended particles. It is not always possible to ascertain by visual observation when an extract is free from this difficulty. Any method based on repeated extraction may be subject to this error, and methods involving

repeated extraction are not recommended. However, it is of interest to compare repeated extraction methods with the one employing a different ratio of sample to solvent. Repeated extraction was carried out as follows:

Triplicate charges of three different samples of flour were extracted with high test gasoline in the customary manner, using 20 grams of sample with 100 cc. of solvent. The transmittancy of the extract was determined and the supernatant gasoline was poured off as completely as possible. Another 100 cc. of gasoline was added and the extraction repeated as before. The transmittancy of the second extract was determined, and the entire operation was repeated until the concentration of carotin in the extract reached a very low value.

The amount of solvent retained by the flour sample was determined under these conditions, the average of eighteen such determinations being 19.94 cc. In the calculations employing this value it was taken to be 20 cc. The amount of carotin contained in the 20 cc. was calculated from the transmittancy of the corresponding extract, and this correction was applied in subsequent determinations of carotin concentration.

TABLE VII

PER CENT TRANSMITTANCY AND CONCENTRATION OF CAROTIN\* IN EXTRACTS RESULTING FROM THE REPEATED EXTRACTION OF FLOUR WITH GASOLINE  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

	Extraction No.				Carotin concentration in combined extracts
	1	2	3	4	
Sample A					
Per cent transmittancy	11.8	55.3	72.3	91.0	
Carotin—determined	2.410	0.670	0.365	0.110	
Carotin—calculated		0.402	0.112	0.061	
Additional carotin—extracted		0.268	0.253	0.049	2.98
Sample B					
Per cent transmittancy	21.0	63.0	80.3	91.6	
Carotin—determined	1.720	0.520	0.250	0.105	
Carotin—calculated		0.287	0.087	0.042	
Additional carotin—extracted		0.233	0.163	0.063	2.179
Sample C					
Per cent transmittancy	16.9	61.8	82.1		
Carotin—determined	2.060	0.545	0.225		
Carotin—calculated		0.343	0.091		
Additional carotin—extracted		0.202	0.134		2.494

\*Carotin—parts per million of sample.

Had the carotin been completely extracted the first time, a determination of the carotin concentration the second time should have yielded a value corresponding to the dilution by 100 cc. of solvent of the quan-

tity contained in the 20 cc. of solvent that the flour retained. In Table VII, where the data are reported, the figures labelled "carotin—calculated," were obtained by such a calculation.

It will be noted that the amount of carotin actually determined in the second and successive extracts was always greatly in excess of the amount it should have contained on the assumption of complete extraction by previous treatment. Thus it was again evident that adsorption of carotin by the flour was an important consideration in the determination of the carotin concentration of the flour itself. In calculating from these data the correction to be applied to the carotin concentration obtained by the first extraction of the sample, it appeared that the determined amount should be increased by about 20 per cent. Stated in another way, the single extraction with gasoline removed about 80 per cent of the total amount of pigment in the sample.

The combined data show that a single extraction of a flour sample with petroleum ether or gasoline did not remove all the carotin from the sample as determined by spectrophotometric measurements. They further indicate that the previously outlined method for the determination of carotin is a purely *conventional* one, whose details must be adhered to where comparable results are desired.

In certain samples that yield extracts with a low transmittancy because of a large carotin concentration, it might appear desirable to use a smaller charge than 20 grams with 100 cc. of solvent. That these procedures are not comparable with one another is indicated by the data. The preferable procedure would be to extract 20 grams of sample with 100 cc. of gasoline in the customary manner, and to dilute the resulting extract with pure solvent (in a definite manner). From the dilution employed the transmittancy can be calculated for the conventional sample-to-solvent ratio. This calculation is possible because dilute solutions of carotin obey Beer's law and the concentration of carotin in petroleum ether solution is directly proportional to the negative logarithm of the transmittancy.

An alternative method is afforded by the use of a cell of less thickness. The transmittancy of the solution determined, for example, in a 1-cm. cell, may be calculated to the transmittancy in a 10-cm. cell by the relation:

$$T^{\frac{1}{t}} = T'^{\frac{1}{t'}}$$

where  $T$  is the transmittancy and  $t$  the cell length. This relation was previously mentioned.

The above calculation from a cell of one thickness to a cell of another thickness is eliminated if the thickness of the cells used is confined to those for which the relation of the concentration and the transmittancy have been determined and plotted in Figure 1.

It is evident from the data obtained that neither the repeated extraction method nor the method of changing the ratio of sample to solvent yielded results for the concentration of carotin in flour that may be considered absolute. They serve to indicate the approximate magnitude of the correction that must be applied to determinations of carotin according to the conventional method adopted. So many factors are operative in giving variable results, that it appears improbable that the concentration of carotin in flour can be determined with absolute accuracy by any known procedure. Among the variable factors that may influence the results are granulation of the flour sample, colloidal properties peculiar to the individual sample, time of extraction, temperature, and moisture content.

An example of the type of difficulty referred to is well illustrated in the experiments of Palmer (1922, p. 207) on blood serum. It developed that the direct extraction of the carotinoid pigment from blood with the ordinary fat solvents was unsuccessful. He accomplished the removal of carotin from blood serum by treating the serum first with alcohol, after which he could extract the pigment with any of the usual solvents. The carotin in blood appears to be held in some physico-chemical combination with the colloidal albumen. It is entirely possible that the carotin in flour is associated in some way, at least in part, with the flour proteins, and as the fat solvents have little effect on protein substances, it is conceivable that a certain amount of the pigment may be bound by them. Palmer's experiment suggests the use of alcohol for a preliminary extraction of the pigment from flour. The difficulty with this procedure is that alcohol dissolves an appreciable quantity of the pigment, and this would vitiate quantitative results in the subsequent extraction of the sample with petroleum ether.

Perhaps some combination of solvents can be found that will more nearly extract all the carotin in a sample of flour than does petroleum ether or gasoline. The adoption of such a solvent would necessitate a determination of the specific transmissive index of pure carotin in the mixture of solvents employed. From these data a new curve showing the relation between the per cent transmittancy and carotin concentration could be drawn for the appropriate cells, and used in the quantitative estimation of the flour pigment.

### An Experiment to Determine the Efficiency with Which Gasoline Extracts Carotin from the Milled Products of Wheat

A sample of Marquillo wheat (No. 500) was milled on an experimental mill. The product was divided into four parts, namely, patent flour, clear flour, shorts, and bran. An accurate milling record was kept in order to determine the percentage of each of these products. The weight of the products obtained is recorded in Table VIII together with their moisture content. The percentage yield of each was calculated on the moisture-free basis. The transmittancy of each of the products with the exception of the bran was determined in the conventional manner, using 20 grams of sample with 100 cc. of gasoline and conducting observations in a 10-cm. cell at a wave length of 435.8 m $\mu$ . The bran proved too bulky to use in the ordinary proportion, and 10 grams with 100 cc. of solvent was employed instead. The data for the transmittancy measurements with the corresponding parts per million of carotin are recorded in Table VIII. In another column the parts per million of carotin are recorded, calculated on a moisture-free basis. From the percentage of each product yielded in milling the proportional amount of carotin contributed by each was calculated, and the sum totalled 4.53 parts of carotin per million of flour.

TABLE VIII

THE EFFICIENCY WITH WHICH GASOLINE EXTRACTED CAROTIN FROM THE MILLED PRODUCTS OF MARQUILLO WHEAT, AS SHOWN BY THE PER CENT TRANSMITTANCY OF THE EXTRACT AND THE CONCENTRATION OF CAROTIN IN PARTS PER MILLION OF SAMPLE  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

Milled product	Grams of product yielded in milling	Per cent of moisture	Per cent of yield on moisture-free basis	Per cent transmittancy	Parts per million determined	Carotin concentration	
						Parts per million on moisture-free basis	Parts per million ratioed according to per cent product yielded in milling
Patent flour	1045	14.93	52.18	4.60	3.49	4.16	2.14
Clear flour	370	14.24	18.61	4.20	3.60	4.20	0.78
Shorts	160	12.84	8.18	6.50	3.09	3.55	0.29
Bran	420	14.41	21.08	9.3*	5.40	6.30	1.32
Total	1995	.....	100.05	.....	.....	.....	4.53
Whole wheat	.....	14.53	.....	3.65	3.75	4.40	.....
Composite whole wheat †	.....	.....	.....	3.75	3.72	4.38	.....

\*10 g. with 100 cc. solvent. †Composed of the mixed milled products proportioned according to milling yield.

A sample of the whole wheat was very finely ground and the transmittancy determined in the customary manner. On the assumption that the entire coloring matter extracted was carotin the parts of carotin per million of sample determined were 4.40, calculated to a

moisture-free basis. The above figure was in substantial agreement with the value previously determined, 4.53.

A composite whole wheat sample was then prepared by adding the milled products together in the proportion in which they were yielded in milling. The weighings were made on a balance that was accurate to a centigram. After thoroly mixing, the transmittancy of the gasoline extract of the composite sample was determined. The carotin concentration corresponding to this transmittancy, calculated to a moisture-free basis, was 4.38 parts per million.

The data show that it is possible to account for flour color (determined as carotin) in each of the wheat fractions when transmittancy measurements are made on their gasoline extracts. When the concentrations of carotin in each of the wheat fractions were added together, a slightly higher value was secured than was obtained with the finely ground sample of whole wheat and the composited sample. The discrepancy, which is small, was probably due to an error in the determination of carotin in the bran fraction. Bran is very difficult to grind finely, and the amount of pigment extracted by gasoline was found to depend on its degree of fineness. Another factor that contributed an error was the assumption that the gasoline extract of bran contained only carotin. It was demonstrated, as reported elsewhere, that the bran pigment was not identical with the carotinoid pigment of the endosperm. The calculations of carotin concentration for bran, recorded in Table VIII, were made on the assumption that the pigment was entirely carotin. It was impossible to make a correction for whatever other pigment was present in the gasoline extract.

An experiment was carried out to learn whether or not bran was a limiting factor in determining flour color by the spectrophotometric procedure. For this purpose a sample of patent flour (Marquillo) and finely ground bran were used. The transmittancy of each was determined in the conventional manner. Mixtures of the flour and bran in definite proportions were prepared, and their transmittancy was measured. The concentration of carotin expressed in parts per million was found in the manner previously discussed. For this purpose, it was necessary to assume that the color contributed by the bran to the extract was due to carotin, an assumption known to be erroneous. The concentration of carotin in the mixtures was also calculated from a knowledge of the carotin concentration in each alone. The data are recorded in Table IX. The calculated values for carotin concentration were found to be in good agreement with those experimentally determined. Oddly enough, the variation diminished with increasing proportions of bran.



*A priori*, the reverse was expected, due (1) to the known fact that the bran pigment is not carotinoid, and (2) to the expectation that the ground bran would adsorb carotin from solution in the same manner that paper pulp did. The data indicate clearly, however, that bran was not a limiting factor in the determination of flour color on the assumption that the color extracted by petroleum ether was due entirely to carotin. It appears that the color of lower grades of flour can be measured spectrophotometrically by the method described as well as the higher grades of flour. These data are of interest in connection with the statement of Coleman and Christie (1926a) that "the gasoline color test can be applied to the wheats as successfully as to the flours." Perhaps the milled products from certain varieties of wheat with a heavily pigmented bran could not be included in this generalization. The extent to which bran is present in any milled product would obviously be a factor.

TABLE IX

EFFECT OF THE PRESENCE OF BRAN IN FLOUR ON THE ACCURACY OF SPECTROPHOTOMETRIC MEASUREMENT OF FLOUR COLOR  
(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ )

Per cent of patent flour and bran in the sample	Per cent T	Carotin concentration, parts per million			Carotin concentration, parts per million on moisture-free basis		
		As determined	Calculated from proportion of flour and bran	Variation	As determined	Calculated from proportion of flour and bran	Variation
100% patent flour	4.6	3.49	.....	.....	4.10	.....	.....
75% patent flour	3.3	3.87	3.59	0.28	4.54	4.22	0.32
25% bran							
50% patent flour	3.4	3.83	3.70	0.13	4.49	4.33	0.16
50% bran							
25% patent flour	3.7	3.74	3.79	0.05	4.36	4.44	0.08
75% bran							
100% bran	3.2	3.90	.....	.....	4.56	.....	.....

It was shown previously that the absorption spectra of carotin and bran extract were unlike, and that the bran pigment was not a carotinoid. It seems strange, therefore, that the bran pigment should not interfere in the quantitative estimation of flour color in instances where bran was present. The following explanation is suggested. The spectral distribution curves of carotin solutions and bran extract (both in petroleum ether), while different in other respects, may cross the wave length of 435.8 m $\mu$  at nearly the same place when solutions having

closely similar color saturations are compared. This would mean that the transmittancies of solutions of carotin and bran extracts in petroleum ether were similar at a wave length of 435.8 m $\mu$  providing their color saturations were comparable. Such a circumstance would be purely fortuitous. It would explain, however, why in the study made the effect of each appeared to be additive in the range of concentrations encountered in flour color measurements. A study of the spectral distribution curves of carotin solutions, flour extracts, and bran extracts is in progress, and the preliminary data suggest the explanation given.

### Variability in the Determinations of the per Cent Transmittancies of Flour Extracts

It appeared desirable to determine the accuracy with which transmittancy measurements could be made on the gasoline extracts of flour. To this end the transmittancies were grouped into ten classes, each having a range of 10 per cent. As stated before, it was customary to take ten readings of transmittancy for each sample and report the average. The standard deviation of each individual determination was calculated, as well as the coefficient of variation. The given value of the transmittancy of each range was likewise calculated. The statistical data are reported in Table X.

TABLE X

VARIABILITY IN DETERMINATIONS OF THE PER CENT TRANSMITTANCY (T) OF FLOUR EXTRACTS IN DIFFERENT RANGES

(Observations conducted in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

Class range	0-10	11-20	21-30	31-40	41-50
Mean value of average T	7.681	15.170	25.209	39.287	44.555
Probable error of mean	$\pm 0.048$	0.099	0.140	0.163	0.173
Standard deviation of average T	0.227	0.315	0.657	0.766	0.810
Probable error of standard deviation	$\pm 0.034$	0.048	0.099	0.116	0.122
Coefficient of variation	2.82	2.10	2.62	2.28	1.82
Number of individuals	86	147	44	42	20
Class range	51-60	61-70	71-80	81-90	91-100
Mean value of average T	55.895	64.470	77.200	85.892	92.520
Probable error of mean	0.198	0.284	0.275	0.289	0.336
Standard deviation of average T	0.927	1.332	1.288	1.356	1.577
Probable error of standard deviation	0.140	0.201	0.194	0.205	0.238
Coefficient of variation	1.66	2.07	1.65	1.57	1.71
Number of individuals	20	24	16	13	5

The absolute variation in the percentage transmittancy as measured by the standard deviation increases markedly as the percentage transmittancy increases. When the variability is translated into relative terms, that is, expressed as the coefficient of variation, it decreases in

general as the transmittancy increases. This is due to the fact that the rate of increase in transmittancy is greater than the increase of the standard deviation.

In measuring the transmittancy of dark samples the sectors of the flicker photometer can be lowered vertically by means of a lever. This doubles the illumination and greatly increases the accuracy of the settings in this range, as the scale will then read four times the actual value. Whenever the transmittancy is lower than 25 per cent, advantage can be taken of this provision. A transmittancy of 11 per cent would be read as 44 per cent in the adjustment mentioned. The accuracy of transmittancy measurements in the lower range can no doubt be attributed to the convenience of the increased illumination secured by lowering the sectors as described.

The data show that no advantage in accuracy would accrue from diluting a sample whose transmittancy was low, for the purpose of bringing the transmittancy readings to a higher range.

In the range represented by 91-100 per cent transmittancy, the data reported are for a relatively few individuals. When the transmittancy runs in this range, gasoline extracts of flour are very pale in color, in fact almost colorless. The illumination of the photometric field is rather intense when such a great percentage of the light is transmitted. As a result it is extremely difficult to obtain a satisfactory match of the photometric fields.

#### **Comparison of the per Cent Transmittancy of the Gasoline Extracts of Wheat Varieties and of Their Carotin Concentration**

Samples of flour milled from Canadian wheats were secured through the courtesy of A. G. Whiteside, Central Experimental Farm, Ottawa, Canada. The samples represented straight grade products consisting of approximately 70 per cent of the wheat kernel. The milling was done on an Allis-Chalmers experimental mill, the samples having previously been tempered for 15 hours or more by the addition of sufficient water to bring them up to a moisture content of 15 per cent. The samples were shipped to this laboratory in glass jars with tightly fitting screw caps.

Two sets of data are reported. One set, representing flour from varieties of wheat grown during the 1926 crop season, is reported in Table XI. A smaller series of flours from wheats grown in 1927 is reported in Table XII. The data should be accepted with reservations. A determination of the transmittancy of the gasoline extracts was not

made until some time after the samples had been milled. Consequently some natural bleaching due to aging had taken place. In addition, the data were accumulated during the preliminary stages of this work when the procedure for measuring the transmittancy with the spectrophotometer had not been completely worked out. Consequently the procedure was not necessarily the same as reported in connection with data presented elsewhere. The data should be of interest, nevertheless, as affording a basis for comparing the flour from the wheat varieties, keeping the above limitations in mind.

TABLE XI

COMPARISON OF THE PER CENT TRANSMITTANCY OF GASOLINE EXTRACTS OF STRAIGHT GRADE FLOURS MILLED FROM CANADIAN WHEATS (1926 CROP), AND THEIR CONCENTRATION OF CAROTIN IN PARTS PER MILLION OF FLOUR

(Determined in a 10-cm. cell at a wave length of 435.8  $m\mu$ ., using 10 grams of sample with 100 cc. of gasoline.)

	Milling No.	Where grown	Per cent transmittancy	Carotin, parts per million
Axminster	26.1	Brandon Exp. Farm	25.8	3.08
Ceres	26.2	Brandon Exp. Farm	36.4	2.29
Kota	26.4	Brandon Exp. Farm	30.4	2.62
Marquillo	26.5	Brandon Exp. Farm	14.4	4.39
Parkers Selected	26.7	Brandon Exp. Farm	23.3	3.29
Reward	26.9	Brandon Exp. Farm	40.0	2.06
Garnet	26.12	Morden Exp. Farm	28.2	2.87
Marquis	26.13	Morden Exp. Farm	32.0	2.58
Early Red Fife	26.16	Indian Head Exp. Farm	38.2	2.18
Kitchner	26.18	Indian Head Exp. Farm	32.4	2.54
Supreme	26.26	Indian Head Exp. Farm	38.6	2.16
Garnet	L.W.	Swift Current Exp. Sta.	32.6	2.53
Marquis	L.W.	Swift Current Exp. Sta.	39.5	2.10
Early Triumph	26.37	Rosthern Exp. Station	31.3	2.62
Garnet	26.38	Rosthern Exp. Station	27.6	2.93
Kota	26.40	Rosthern Exp. Station	30.5	2.38
Marquis	26.41	Rosthern Exp. Station	41.8	1.99
Garnet	26.107	Dauphin, Man.	25.5	3.09
Marquis	26.108	Dauphin, Man.	35.9	2.32
Garnet	26.109	Beatty, Sask.	28.8	2.82
Marquis	26.110	Beatty, Sask.	41.8	1.98
Vermillion	26.111	Minburn, Alberta	27.7	2.91
Marquis	26.112	Minburn, Alberta	39.0	2.13
Marquis	26.6	Brandon Exp. Farm	39.3	2.11

In comparing the data reported in the two tables, it should be borne in mind that the transmittancies of the gasoline extracts are not comparable. In Table XI, 10 grams of sample was used with 100 cc. of gasoline and the transmittancy was determined in a 10-cm. cell, whereas the transmittancies reported in Table XII were for gasoline extracts prepared with 20 grams of sample to 100 cc. of solvent. The transmittancies in each table are comparable among themselves, but are not comparable with those in the other table. As the concentration of carotin in the sample is expressed in both tables in parts of carotin per mil-

lion of flour, these figures alone are comparable. The data reported in the tables are in all cases the average values obtained from several determinations on aliquot portions of the same sample.

TABLE XII

A COMPARISON OF THE PER CENT TRANSMITTANCY OF GASOLINE EXTRACTS OF STRAIGHT GRADE FLOUR MILLED FROM CANADIAN WHEATS (1927 CROP), AND THEIR CONCENTRATION OF CAROTIN IN PARTS PER MILLION OF FLOUR

(Determined in a 10-cm. cell at a wave length of 435.8 m $\mu$ ., using 20 grams of sample with 100 cc. of gasoline.)

	Where Grown	Per cent transmittancy	Carotin, parts per million
Kota	Rosthern, Sask., Expt. Sta.	8.8	2.76
Marquis 0-15	Rosthern, Sask., Expt. Sta.	9.8	2.64
Reward	Rosthern, Sask., Expt. Sta.	18.0	1.94
Early Triumph	Rosthern, Sask., Expt. Sta.	10.9	2.51
Early Red Fife	Rosthern, Sask., Expt. Sta.	5.1	3.38
Supreme	Rosthern, Sask., Expt. Sta.	5.0	3.40
Red Fife	Rosthern, Sask., Expt. Sta.	8.0	2.87
Ceres V.T.	Rosthern, Sask., Expt. Sta.	16.2	2.06
Garnet	Rosthern, Sask., Expt. Sta.	13.3	2.21
Kitchner	Rosthern, Sask., Expt. Sta.	6.2	3.19
Preston	Rosthern, Sask., Expt. Sta.	6.6	3.08

A comparison of the flours from the same wheat varieties for the season 1926-27 showed fairly good agreement. The concentration of carotin in the Kota wheat flour for 1926 was 2.62 and 2.38 parts per million, and in the flour from the same variety in 1927, 2.76 parts per million. The flour from the variety known as Reward had a carotin concentration of 2.06 and 1.94 parts per million for the two seasons. These results agree fairly well, that is, the carotin concentration in the two seasons was not greatly different.

The flour from five samples of Garnet wheat, in 1926, ranged from 2.53 to 3.09 parts of carotin per million of flour. The flour from Marquis wheat also varied considerably, the seven samples reported for 1926 ranging from 1.98 to 2.58 parts of carotin per million.

For flours from wheat varieties in the 1926 group the lowest concentrations of carotin were observed in four samples of Marquis wheat flour, with 1.98, 1.99, 2.10, and 2.11 parts of carotin per million. Other wheat varieties yielding flours with low concentrations of carotin were Reward, Supreme, Early Red Fife, and Ceres, which had 2.06, 2.16, 2.18, and 2.29 parts of carotin per million of flour respectively. Reward and Ceres had the lowest concentrations in the 1927 group, with 1.94 and 2.06 parts of carotin per million of flour. Flours from Early Red Fife and Supreme were somewhat higher in carotin than were reported for 1926 samples.

Varieties that yielded flours having the highest concentrations were Marquillo, Parker's Selected, Garnet, and Axminster, which had 4.39, 3.29, 3.09, and 3.08 parts of carotin per million of flour, respectively.

The data for the Marquillo sample are in substantial agreement with samples of Marquillo wheat flour recently milled in this laboratory—three of the latter samples had carotin concentrations of 4.62, 4.44, and 4.70 parts per million. Marquillo wheat yielded flour in all instances with a higher concentration of carotin than was observed in any of the other varieties.

A recently milled sample of flour from a Marquis and Emmer cross grown at University Farm, St. Paul, Minnesota, had a carotin concentration of 2.94 parts per million; a freshly milled sample of the Marquis wheat flour showed a carotin concentration of 3.85 parts per million. The average unbleached straight grade flour milled at the Minnesota State Testing Mill had an average carotin concentration of 2.43 parts per million of flour.

#### **A Study of the Color of Flour Streams from the Minnesota State Testing Mill**

The flour streams that went into the production of straight grade flour at the Minnesota State Testing Mill were sampled for the purpose of this experiment. The nature of these streams is reported in Table XIII. Transmittancy measurements were made on each of the streams in the conventional manner, employing 20 grams of sample with 100 cc. of gasoline, and reading the transmittancy at a wave length of 435.8 m $\mu$ . in a 10-cm. cell. The data reported are the average of at least two determinations of aliquot portions of each sample, and of three determinations with different aliquots on half the number of streams reported.

The data are recorded in Table XIII along with the corresponding concentration of carotin in parts per million of flour. The columns labelled "Per cent flour extraction" and "Grams flour per minute" record data secured from H. L. Shirk, at the Minnesota State Testing Mill. Mr. Shirk determined the quantity of each flour stream delivered in a minute in order to arrive at the per cent of each stream that went into the straight grade flour. His determinations were repeated until closely agreeing results were obtained and these were averaged.

The per cent of each flour stream in the straight grade flour was multiplied by the concentration of carotin it contained and the corresponding proportional concentration of carotin is recorded in the table. These data gave the amount of carotin in parts per million contributed



by each flour stream constituting the straight grade flour. When these were added together the total concentration was 2.41 parts of carotin per million of flour. The per cent transmittancy of the gasoline extract of straight grade flour was then determined and the carotin concentration corresponding to the transmittancy was 2.43 parts per million. These results afford a splendid example of the manner in which the determination of flour color by means of the spectrophotometer can be made accurately and quantitatively.

TABLE XIII

CONCENTRATION OF CAROTIN IN FLOUR STREAMS FROM THE MINNESOTA STATE TESTING MILL, DETERMINED FROM THE PER CENT TRANSMITTANCY OF THEIR GASOLINE EXTRACTS, AND PROPORTION ACCORDING TO THE PER CENT EXTRACTION YIELDED IN MILLING  
(Observations conducted in a 10-cm. cell at a wave length of 435.8 m $\mu$ .)

Flour stream	Per cent transmittancy	Carotin parts per million	Grams of flour per minute	Per cent of straight grade flour	Proportional concentration of carotin
First break	17.2	1.20	122	1.4	0.0168
Second break	14.4	2.19	354	4.06	.0889
Third break	9.9	2.62	158	1.81	.0474
Fourth break	8.0	2.82	140	1.61	.0460
Fifth break	6.2	3.15	149	1.71	.0539
Sizings	12.9	2.32	183	2.09	.0461
First middlings	13.3	2.29	1030	11.80	.2702
Second middlings	13.0	2.31	1218	13.96	.3225
Third middlings	13.8	2.24	574	6.58	.1474
Fourth middlings	12.5	2.35	1191	13.65	.3208
Fifth middlings	11.5	2.45	1158	13.27	.3251
Sixth middlings	11.0	2.50	1276	14.62	.3655
First tailings	9.1	2.72	192	2.22	.0604
Second tailings	9.9	2.62	400	4.59	.1203
Sixth middlings tailings	10.5	2.56	426	4.89	.1252
Bran, shorts and buster	8.2	2.84	152	1.72	0.0485
Total	....	....	....	99.987	2.41
Straight grade flour	11.8	2.43			

The data recorded in Table XIII are of interest in comparing the concentration of carotin in the flour streams that go into the straight grade flour. The first-break flour had the lowest concentration of carotin—1.20 parts per million. The first-break flour is not ordinarily considered high grade from the standpoint of color and the visual appearance of the dry flour is usually gray and dull. It is evident that the inferiority in color is not due to the carotin it contains but rather to dirt and foreign matter.

The fifth-break flour contained the highest concentration of carotin—3.15 parts per million. The amount of this flour stream in the straight grade flour is, however, only 1.71 per cent, a relatively small proportion. The fifth-break flour contained more than two and one-half times the amount of carotin in the first-break flour. The fourth-break flour and

the bran, shorts, and duster flour contained high concentrations of carotin in comparison with the other streams, but relatively small percentages of each are included in the total flour.

Among the middlings flours, the third middlings had the lowest carotin concentration. This was followed in order by the first, second, fourth, fifth, and sixth middlings. However the first, second, and fourth middlings have carotin concentrations practically identical. The middlings flours form a rather large fraction of those that go into the straight grade product, constituting approximately 75 per cent. For this reason their carotin concentration becomes significant in influencing the color of the straight grade flour.

The bran, shorts, red dog, and whole wheat were also sampled in connection with the study of the carotin concentration in the flour streams. Transmittancy measurements made in the usual manner showed the following carotin concentrations:

Bran, 2.88 parts per million.

Shorts, 3.40 parts per million.

Red dog, 2.85 parts per million.

Whole wheat, 3.40 parts per million.

These figures are subject to the limitations imposed by the presence of the unknown bran pigment in their gasoline extracts, a subject previously discussed.

Straight grade flour usually constitutes approximately 73-75 per cent of the whole wheat. On this basis, 73-75 per cent of the carotin found in the whole wheat sample would range between 2.49 and 2.55 parts of carotin per million of flour. The latter figures are likewise in good agreement with the concentration of carotin in straight grade flour determined above as 2.41 and 2.43 parts per million.

#### Literature Cited

Coleman, D. A. and Christie, Alfred

1926a A rapid method for determining the gasoline color value of flour and wheat. *Cereal Chem.* 3:84.

1926b The gasoline color value of several classes of wheat. *Cereal Chem.* 3:188.

Palmer, L. S.

1922 The carotinoids and related pigments. The chromolipins. Chemical Catalog Co., New York.

Schertz, F. M.

1925 Some physical and chemical properties of carotin and the preparation of the pure pigment. *J. Agr. Res.* 30:469-474.

## BOOK REVIEWS

The Development of the Flour-Milling Industry. By C. B. Kuhlmann. \$3.50. Houghton Mifflin Co., Boston, Mass.

This is one of the prize essays of a series sponsored by the Hart, Schaffner & Marx Company, of Chicago. It contains an interesting historical review of the development of the flour milling industry from the colonial period to the present time.

The review is not only instructive from a historical viewpoint but as it deals also with the economic and agricultural development of the country in its relation to the milling industry it clearly explains its gradual centralization and afterwards its decentralization.

Special emphasis has been given to the beginning and growth of the industry in Minneapolis and to the development of the technical improvements originated there. The subsequent decentralization of the milling industry, caused by both the agricultural developments in other sections of the country and the freight-rate structure, is thoroly discussed. Social and commercial associations springing from the desirability and necessities of the modern status of the flour-milling industry are traced from their inception to their present conditions. A brief discussion of the reations of the milling and the baking industry, with a short account of the export trade, concludes the text. The addition of an extensive bibliography makes the book still more valuable to the student. To one connected with the flour industry who, outside of his daily work and routine, is interested in its historical development, this work has much to offer.

—J. T. Flohil.

Die Technologie der Fermente. 1. Halbband. Enzymatische Technologie Der Gärungsindustrien, by Dr. Albert Hesse. 357 Pages, 60 Illustrations. Price, bound, 36 Marks. George Thieme, Leipzig, 1929.

This is the first of a series of volumes on the technology of ferments appearing under the editorship of Professor Carl Oppenheimer. A second volume is announced to appear early in 1929.

In this first volume Dr. Hesse has developed at length the role of enzymes in brew-materials. Five groups of subjects are presented: I. Enzymes and their substrates in malting and mashing; II. Barley as brew-material; III. Malt production; IV. Preparation and separation of wort; V. Malt production and mashing in distilling and related industries.

The reviewer makes no pretense of close familiarity with the technical details of these industries. He has been impressed, however, with the seeming care which Dr. Hesse has exercised in bringing the results of research in biochemistry and zymology to bear upon specific industrial situations.

The development of each section proceeds logically, the separate contributions being organized in a manner that is convenient to the student. An effort has obviously been made to translate the earlier expressions and terminology into modern nomenclature so far as possible.

As a convenient summary and presentation of the voluminous literature in this field, and particularly in the German journals, this book should be of service to those interested in these fermentation industries. It also has a useful arrangement of citations to the original papers pertaining to each subdivision of the text.

—C. H. Bailey.